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MECHANICS OF FLUIDS
... 154
... 156
... 158
... 160
... 161
... 162
... 166
... 167
... 168
... 169
... 170
... 172
... 173
... 176
... 177
... 178
... 178
... 179
... 180

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APPLIED MECHANICS REVIEWS

VOL. 8, NO. 4 MARTIN GOLAND *Editor* APRIL 1955

THE STATUS OF WOOD CONSTRUCTION

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IN any attempt to list steps of progress in the use of wood as a structural material, consideration must be given to the period around 1830 to 1840. Then, such Frenchmen as De l'Orme advanced designs of vertically laminated timber arches of 45-ft span; Emy intuitively designed trussed, horizontally laminated, multiple timber arches up to 300-ft span; and Laves recommended the use of prestressed trussed timber beams and plate girders of up to 30-ft span. In this country, many outstanding timber structures were erected and both the Howe and Pratt parallel-chord trusses were developed during the same period.

Outstanding progress in the use of wood as a structural material again was made early during this century when structural analysis was applied to timber structures on the basis of knowledge gained in designing with steel as a competitor of wood.

The third step, in close relationship with and possibly even an integral part of the second step, can be placed within the past twenty-five years when timber connectors were introduced and synthetic-resin glues brought about modern laminated timber and stressed-skin structures, thus providing an effective solution to the ever-present problem of satisfactorily jointing the wood members.

Presently, I think, we are at the start of a fourth step in the development of the field of wood construction when both today's technology and knowledge gained in designing timber structures with timber connectors are applied to the assembly of wood with nails—the most common fastener since the invention of the common-wire nail in France during the same period during which timber construction found such an impetus in that country. This is a period when the design of nailed structural joints should be based on engineering data instead of "precedent, tradition, and individual judgment."

The third phase referred to previously resulted in (a) 100-ft long, laminated beams, each containing 10,000 bd ft of lumber and weighing 16,000 to 17,000 lb; (b) economical timber trusses of 200-ft span; (c) wood and plywood plate-girder frames of 150-ft span; (d) glued laminated arches of 250-ft span; (e) trussed timber arches of 240-ft span and 150-ft height; (f) timber highway bridges for H-20 loading of 100-ft span; (g) wood minesweepers of 165-ft length; (h) a 28-acre warehouse spanned by 773 timber trusses; and (i) stressed-skin walls for prefabricated houses and lightweight structural components and structures.

The fourth step, if it can be called that, is to benefit mostly the builder of small structures, the farmer, the pallet, skid, box, furniture, and other wood-products manufacturer, and the boat builder who can erect better structures and build better wood assemblies possibly even at less cost than previously feasible.

The theoretical knowledge underlying this improved engineering use of wood and wood products still is in its initial stage of development, despite the fact that the basis for this development was laid some fifteen years ago when large-scale design and testing programs for timber structures were initiated in Germany, Sweden, and the United States and when mass production of improved wire fasteners was initiated in this country. By correlating the varied design experiences and the application of improved wire fasteners, the present promising stage is reached where wood can be used more economically and to greater advantage than had previously been the case.

Some of the relatively recent developments in the improved application of wood as a structural material are described in the following bibliographical survey of research and development work which led to the present status in the various fields of wood construction.

A GENERAL

Texts and comprehensive papers covering the field of wood construction are of particular interest (1–11).[1] Reports are listed on research performed at the U.S. Forest Products Laboratory (12). Other basic research on timber formwork (13), built-up wood columns (14–16), end-splicing of framing lumber (17), and lumber roof diaphragms (18) was published. Trade specifications were brought up to date (19) or issued (20). Several interesting structural designs were advanced (21–30). Certain structural analyses were made (31–34).

B BOLTED CONSTRUCTION

Supplementary information on the effectiveness of bolted joints was presented in Sweden (35), Germany (36), and the United States (37–38).

[1] Numbers in parentheses indicate References at end of paper.

C CONNECTORED CONSTRUCTION

Connectored joints were investigated in Sweden (39–40), Norway (41), Austria (42–43), the United States (44–45), and Germany (46–49). Connectored trusses were investigated (50–52) and generally discussed (53–54). Connectored trussed rafters were given detailed consideration (55–57) and tested (58). Standardized designs were made available to engineers and architects (59).

D NAILED CONSTRUCTION

Studies covering nailed structures were carried on to a considerable extent in Germany especially just before, during, and after World War II (60–71), in Austria (72), in Sweden (73–74), and in Japan (75). Recent Norwegian specifications for timber structures take into account many of these developments (76). Nailed built-up beams (77) and box columns (78), nailed house frames (79) and trusses (80) were tested in the United States, where also a theoretical study concerning the design of nailed joints was undertaken (81). Studies on nailed three-member joints (82) allowed the improved design of nailed trussed rafters, somewhat similar to those advanced in Indonesia (83). They were investigated at Virginia Polytechnic Institute (84–86). The results of all of these studies provided information on the effectiveness of predrilling; use of softwood, hardwood, and plywood splice and gusset plates; low- and high-carbon-steel, hardened, threaded and fluted nails in single and double shear, driven straight or slanted and under static and dynamic load application. Comparative effectiveness of fasteners used for various building components was given detailed consideration (87–97).

E GLUED-LAMINATED CONSTRUCTION

Progress in glued-laminated structures was summarized (98). This progress resulted from studies performed at the U.S. Forest Products Laboratory (99–103). The high standard of glued-laminated construction in the United States is based on such specifications as are promoted by the various trade groups promulgating such structures (104–106). Additional papers covering the design and production features of glued-laminated structures are numerous (107–139).

F NAILED AND GLUED CONSTRUCTION

Studies of nailed and glued structures advanced this type of construction especially in northern European countries (140–142), from where they were introduced to the American continent (143–144). Glued and nailed girders were studied in Europe (145) and trussed rafters were investigated at the U.S. Forest Products Laboratory (146) and at the University of Illinois (147).

G NAILED AND CONNECTOR-REINFORCED CONSTRUCTION

Nailed built-up lumber trusses, with their joints reinforced with toothed steel plates, through which the nails were driven, were introduced in Sweden (148), thus combining nailed and connectored construction. Such assemblies are particularly promising for structures which cannot be glued successfully and which call for relatively large resilience, rigidity, and load-carrying capacity as are required, e.g., for pallets (149).

H PLYWOOD CONSTRUCTION

Studies covering the basic aspects of plywood for structural purposes have been made available from time to time (150). The design of plywood beams was analyzed (151–153). Comprehensive reports on plywood as a structural material cover tests on plywood columns and box beams (154–155), plywood plates (156), and roof diaphragms (157). Surveys show the structural application of flat plywood (158) and correlated plywood (159), including that for grain silos (160).

I STRESSED-SKIN CONSTRUCTION

Studies of wood and wood-base materials for stressed-skin sandwich constructions are covered in numerous reports by the U.S. Forest Products Laboratory (161).

EFFECT OF CONSTRUCTION WITH IMPROVED NAILS

Referring to nailed construction, studies of the elements of timber structures resulted in the following developments through the use of improved wire fasteners:

1 Nailed trussed rafters of 18 to 36-ft span and 3 in 12 to 6 in 12 pitch with nails loaded in double shear in the three-member joints. These trussed rafters are more rigid and stronger, more economical and easier to build than any of their prototypes. They are used throughout this country and Canada as indicated in a leading trade magazine which is publishing these designs in a continuing series of articles.

2 House frames strengthened approximately five times by the use of threaded instead of common-wire nails, resulting in possibly stronger and longer-lasting houses while using less nails than considered necessary prior to the use of threaded nails.

3 Nailed or nailed and glued industrial plate girders utilizing thin lumber which is commonly available even in dry condition and can be assembled without any special tools by unskilled labor.

4 Pole-type structures where threaded nails firmly connect the structural members to the pressure-treated creosoted poles, while common-wire nails lose some of their often initially, even inadequate, holding power while in service.

5 Wood-box-column design data allowing the use of these extremely strong structural elements in engineered structures.

6 Farm fences where the threaded L-shaped fence staples fasten the fence wire to the pressure-treated posts for the lifetime of the fence, in contrast to the conventional U-shaped staple which has little holding power in treated posts after exposure of the fence to the weather.

7 Reinforced nailed pallets providing twice the rigidity and strength of standard pallets, thus offering longer service life even under adverse conditions.

8 Auto-nailed skids, box shook, and other wood, plywood, and modified-wood assemblies, rigidly jointed with multiple knurled wire pins at a driving rate of as many as three pins per second and considerably stronger than the conventionally nailed assemblies, if such supplementary strength is desired.

9 Pleasure and speed boats racing at speeds of up to 185 mph and resisting such internal dynamic stresses as are caused by these speeds, as a result of the use of threaded Monel nails in preference to conventional wood screws creeping under such extreme service conditions.

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F NAILED AND GLUED CONSTRUCTION

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H PLYWOOD CONSTRUCTION

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Books Received for Review

BIEZENO, C. B., AND GRAMMEL, R., Engineering dynamics. Vol. I. Theory of elasticity: Analytical and experimental methods, London, Glasgow, Blackie & Sons, 1955, viii + 307 pp. 50 s.

EDWARDS, J., A treatise on integral calculus with applications, examples and problems, Vols. I, II, New York, Chelsea Publishing Co., 1954, xxi + 907 pp., xv + 980 pp. $6.50 ea.

HUETER, T. F., AND BOLT, R. H., Sonics—techniques for the use of sound and ultrasound in engineering and science, New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1955, xi + 456 pp. $10.

KALWEIT, H., Der Wasserhaushalt. Vols. I, II, Berlin, VEB Verlag Technik, 1953, 408 pp., 200 figs.; 277 pp. of tables, figs., 8 maps.

KELDYSCH, W. M., edited by (Baldin, W. A., Goldenblat, I. I., Kotschenow, W. M., Pildish, M. J., and Tal, K. E.), Berechnung von Baukonstruktionen nach den Grenzbeanspruchungen (translation from Russian), Berlin, BEV Verlag Technik, 1953, 257 pp.

MCNEIL, I., Hydraulic operation and control of machines, London, Thames & Hudson, Ltd., 1954, xi + 324 pp. 35 s.

RINEHART, J. S., AND PEARSON, J., Behavior of metals under impulsive loads, Cleveland, Ohio, American Society for Metals, 1954, 256 pp.

SCHMIDT, H., Einfuhrung in die Vektor- und Tensorrechnung. Berlin, VEB Verlag Technik, 1953, 116 pp.

SWAINGER, K., Analysis of deformation. Vol. 2, Experiment and applied theory, London, Chapman & Hall, Ltd., 1954, xxxvi + 365 pp. 70 s.

TEMPLETON, H., Mass balancing of aircraft control surfaces (Aeronautical Monographs 4, published under the authority of the Royal Aeronautical Society), London, Chapman & Hall, Ltd., 1954, x + 241 pp. 35 s.

TSIEN, H. S., Engineering cybernetics, New York, Toronto, London, McGraw-Hill Book Co., Inc., 1954, xii + 289 pp. $6.50.

Letters to the Editor

899. Re feature article, AMR 8 (Jan. 1955): W. Olszak, Prestressing.

It has been called to our attention that the following corrections should be made to certain of the references given in Professor Olszak's article. Unfortunately, due to postal delays, Professor Olszak was unable to check the proof before its release.

The corrections are as follow:

(A1) *ACI Journal*, Jan. 1945; Proc., vol. 41, p. 181.

(D4) *ACI Journal*, May 1950; Proc., vol. 46, p. 713.

(M12) *ACI Journal*, Jan. 1952; Proc., vol. 48, p. 405.

(S2) (a) *ACI Journal*, June 1943; Proc. vol. 39, p. 493.

(S2) (b) *ACI Journal*, Sept. 1946; Proc. vol. 43, p. 49.

(U1) *ACI Journal*, Nov. 1950; Proc. vol. 47, p. 197.

(W1) *ACI Journal*, May 1950; Proc. vol. 46, p. 693.

We have also been advised of a Bibliography on Prestressed Concrete, published by the American Concrete Institute, 18263 West McNichols Road, Detroit 19, Mich., price $2 per copy.

Ed.

Theoretical and Experimental Methods

(See also Revs. 937, 941, 947, 965, 1050, 1055, 1060, 1088, 1094, 1095, 1097, 1117, 1118, 1123, 1148, 1158, 1159, 1175, 1206)

900. Erdélyi, A., Magnus, W., Oberhettinger, F., Tricomi, F. G., Tables of integral transforms. Vol. II (Bateman Manuscript Project), New York, McGraw-Hill Book Co., Inc., 1954, xvi + 451 pp. $8.

History of project has been developed in AMR **7**, Rev. 1365; for a review of vol. I of set, see AMR **7**, Rev. 2056. In addition to lists of transforms, the present tome tabulates integrals of higher transcendental functions. Over 2200 entries are found. Volume begins with chap. 8, a list of Hankel transforms. Next three chapters tabulate Y, K, and H transforms. These are of the same type as Hankel transforms where Bessel function kernel of first kind is replaced by that of the second kind, modified function of second kind, and Struve's function, respectively. Kontorovich-Lebedev transforms are in chap. 12. Chap. 13 details fractional integrals of Riemann-Liouville and Weyl. These are essentially integrals of Duhamel type where kernel has form $(x - y)^{\mu-1}$. Chaps. 14 and 15 are devoted to Stieltjes and Hilbert transforms, respectively. Remainder of volume deals with integrals of higher mathematical functions which may be, but most often cannot be, written as transforms. Both definite and indefinite integrals are considered. Thus chap. 16 considers integrals involving orthogonal polynomials of Chebíshev, Legendre, Gegenbauer, Jacobi, Hermite, and Laguerre. Integrals involving gamma functions, incomplete gamma functions, and related functions (e.g., error function) are treated in chap. 17. Integrals involving Legendre functions are found in chap. 18. Chap. 19 contains integrals of both definite and indefinite type involving all kinds of Bessel and associated Bessel functions. Chap. 20 is similar but for hypergeometric functions. Entries have been taken from numerous sources and many are new.

Vols. I and II are designed to enable the applied worker to evaluate integrals with a minimum of effort. This is an outstanding work and fills a long-felt need. Y. L. Luke, USA

901. Staff of the Computation Department, Polylogarithms, Part I: Numerical values, *Comput. Dept. Math. Centre, Amsterdam Rep. R* 24, 53 pp., 1954.

Functions defined for $|z| < 1$ by $F_\nu(z) = \sum_{k=1}^{\infty} k^{-\nu} z^k$ and for other values of z by analytic continuation are called polylogarithms of order ν and argument z. If order is integral, it is denoted by n. For $n = 1(1)12$, Table I gives values for $z = x = -1(0.01)1$. Table II is similar, but $z = ix$ and $x = 0(0.01)1$. Table III gives function for $z = e^{1/2\pi\alpha}$, $\alpha = 0(0.01)2$, and for n as above. Maximum error is said to be a unit in the tenth decimal.

Y. L. Luke, USA

902. Higgins, T. J., Basic books on computers and numerical analysis, *Control Engng.* **2**, 1, 57–61, Jan. 1955.

903. Whitehead, T. N., The design and use of instruments and accurate mechanism—underlying principles, New York, Dover Publications, Inc., 1954, xiv + 283 pp. $1.95.

Book is one of a new series of paperbound scientific books and is a second printing of the first edition (1933). It contains the following chapters: (1) Instruments and their parts; (2) Systematic errors (false elements); (3) Probability as applied to errors; (4) Short period errors (disturbed elements); (5) Erratic errors (incomplete elements); (6) Elements with mental restoring agencies; an example; (7) Precision. Kinematic design; (8) Precision. Semikinematic design; (9) Stiffness, isolation, and protection of elements; (10) Accuracy; (11) The planning of an instrument; (12) The human factor. Ed.

904. Birkhoff, G., Hydrodynamics. A study in logic, fact, and similitude (in Russian), Moscow, Publ. of Foreign Lit. (I.L.), 1954, 182 pp. $1.10.

This is a Russian translation of the 1950 publication [AMR 3, Rev. 2692]. In a four-page foreword, L. I. Sedov calls attention to his own treatise on "Methods of theory of dimensions and theory of similitude," published in 1944, which, in part, contains somewhat similar considerations and examples and calls attention to some ambiguities which he attributes to the terminology rather than to the actual subject. The book is well produced and, in addition to original references, includes 38 references of Russian sources. J. L. Koffman, England

905. French, C. S., Towner, G. H., Bellis, D. R., Cook, R. M., Fair, W. R., and Holt, W. W., A curve analyzer and general purpose graphical computer, *Rev. Sci. Instrum.* **25**, 8, 765–775, Aug. 1954.

Authors describe an analog computer, constructed at Carnegie Institute of Washington, to perform simple operations on graphs. Its components are those of a differential analyzer, but authors' interest centers on (e.g.) addition, multiplication, or nonlinear transformations, of graphs, rather than on differential equations; hence five automatic curve-followers are included, and only two integrators. A typical use is analysis of spectrophotometric data by fitting a sum of normal-distribution curves to an empirical curve. Using specially designed a-c amplifiers and photoelectric curve followers, computer can plot results (accurate within 0.1 to 1.0% of full scale for most problems) at 20 sec to 2 min per run. An example is given of the solution of the differential equation: $dy/dx = x + (1/2) \cdot y^2$.

J. P. Mayberry, USA

906. Andersen, N. Y., The C.A.L. versatile strip-chart reader, *Cornell aero. Lab., Inc. Rep.* C.A.L. 64, 9 pp., Aug. 1954.

907. Burgess, E., The component integrator: Can you use an unusual computing device? *Control Engng.* **1**, 2, 32–34, Oct. 1954.

Ball-and-disk integrators are commonplace in fire controls, navigational computers, and many other mechanical computing systems. A less familiar cousin is this spherical integrator. One roller spins the sphere. The speed and axis of rotation determine a particular mathematical function. Two other rollers "read off" the integrals—not of the function itself, but of its components paralleling the x-axis and y-axis. The spherical integrator is used in some navigational computers, but its peculiar properties should fit it for many other jobs. This article tells why this computer works, how it is constructed, and what it can do.

From author's summary

908. Vladzievskiĭ, A. P., Losses of working time as a function of dividing the production lines into stations (in Russian), *Stanki i Instrum.* **24**, 10, 9–15, Oct. 1953.

Formulas expressing the efficiency of continuous production

lines as a function of their stations and supply of parts between these stations proposed by author have been challenged in print [Yu. B. Erpsher, "Losses of working time as a function of dividing the production lines into stations," title source, nos. 6, 7, 1952]. The coefficient of accumulation of intrastational losses δ entering all formulas, and which is the bone of contention, can be expressed as $\delta = 1:(1 + k\bar{T}\bar{Z})$ where $\bar{T}$ is average length of the action cycle of an automatic line, k parameter of the exponential distribution of probabilities of the length of the setting time, $\bar{Z}$ average supply of parts between each two stations of the line expressed in units. This formula can be deduced based on all conceivable levels of parts supply, taking into account all subsequent replenishments and diminutions of it. The formula presents a chain problem in the theory of probabilities and can be solved by the methods forming the subject of the A. A. Markov theory of probabilities. The present paper gives mathematical derivation of the value of δ by the Markov method. The results obtained are identical with the formula given above.

J. D. Gat, USA

909. **Kirpichev, M. V., Dimensional analysis** (in Russian), *Izv. Akad. Nauk SSSR Otd. tekh. Nauk* no. 9, 1330–1340, Sept. 1953.

Mechanics (Dynamics, Statics, Kinematics)

(See also Revs. 956, 1055, 1235, 1236)

910. **Garnier, R., Kinematics. Vol. I. Kinematics of points and of solids; compound motion** (in French), Paris, Gauthier-Villars, 1954, ix + 244 pp.

This book deals with the geometry of motion, leaving the forces and couples causing the motions out of consideration.

In France, instruction in mechanics is initiated by an easy but thorough course in kinematics, like this one. After that, the students can profit by a concise course in dynamics and statics, like Pérès, "Mécanique générale" [see AMR **7**, Rev. 695]. Therefore the book is written for readers who want a broad exposition which is simple, clear, and almost without misprints. This book contains proofs in full detail, not only for the fundamental theorems but also for almost self-evident propositions.

Contents: *Kinematics of points:* Velocity and acceleration. Frenet's formulas and other theorems about skew curves are deduced as consequences. *Kinematics of solids* begins with a thorough theory for helical (screw) motion. Some theorems in the geometry of space follow as consequences, viz., about screw surfaces and translation surfaces. Acceleration and center of acceleration. *Compound motion:* Coriolis' theorem. Applications. Motion of a solid with a fixed point. Euler's angles. Determination of the motion of a solid by its velocity field.

The book was first printed in 1940. This third edition is revised and a good deal enlarged. O. H. Faxén, Sweden

911. **Shaffer, B. W., and Cochin, I., Synthesis of the four-bar mechanism when the position of two members is prescribed,** *Trans. ASME* **76,** 7, 1137–1140, Oct. 1954.

See AMR **7**, Rev. 1710.

912. **Chiang, C. H., Semi-graphical solution of acceleration problems of plane cam-driven roller followers and four-bar linkages,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-15, 16 pp.

The method presented is based on the well-known theorem that the relative motions of two planes, Q_1 and Q_2, each of which has a rotary motion with respect to a third plane, Q_3, is again a rotation. Hereby the instantaneous center of this relative motion, P_{12}, lies on the connecting line of the other two centers of rotations, P_{13} and P_{23}, and divides the connecting line by the inverse ratio of the angular velocities ω_{13} and ω_{23}.

The construction developed avoids the use of velocity and acceleration polygons. It is applied by the author for the determination of follower acceleration on the subsequent mechanisms: cam-driven oscillating roller follower, cam-driven reciprocating roller follower, straight-edged cam-driven roller follower, flat-plate-driven pointed follower, scotch yoke, oblique slider, swinging-block linkage, train of four-bar linkages, and double slider-crank mechanism.

This method requires only a relatively small number of construction lines enabling the design engineer to obtain more accurate results more easily.

A similar amount of simplicity and accuracy is inherent in the velocity and acceleration construction published by R. Land.

J. Boehm, USA

913. **Müller, J., The design of link mechanisms with eight members without four-bar links** (in German), *Maschinenbau-Technik* **3,** 4, 213–217, Apr. 1954.

Among the various combinations of link mechanisms with eight members, there is only one chain which does not contain any four-bar links (12 possibilities are quoted, but an advance copy of a paper by P. Grodzinski and Ewen M'Ewen, "Link mechanisms in modern kinematics," presented to Instn. mech. Engrs., Aug. 1954, quoted 15 variations. The one discussed in this paper is variation p). This particular chain can be used in three variations; in two of them a threefold member is used as base, in the third a twofold member is used as a base. The article shows design methods for determining the dimensions of such mechanisms by means of the Burmester Mittelpunkt curve and the relative positions, so that to given positions of the driving crank, both oscillating members assume prescribed positions. This seems to be the first attempt of synthesis of eight-bar linkages for producing periodic movements.

The author warns that the use of these mechanisms is only justified if the prescribed movements cannot be obtained with linkages of a smaller number of members. However, the investigation seems to be of particular interest in the redesign of existing machines, if use should be made of already existing bearings in the machine frame. Owing to the high number of links, a number of link dimensions can be freely selected so that certain additional requirements, such as the most favorable crank dimensions, special quality of the movement, etc., can be fulfilled.

P. Grodzinski, England

914. **Rotinyan, L. A., Plotting three-dimensional three-membered mechanisms** (in Russian), *Akad. Nauk SSSR Trudi Sem. Teorii Mash. Mekh.* **14,** 53, 11–19, 1953.

915. **Groeneveld, B., Geometrical considerations on space kinematics in connection with Bennett's mechanism,** Thesis, Technological Univ., Delft, Holland, 112 pp., June 1954.

916. **Gray, H. C., The geometry of crossed helical involute gears,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-10, 22 pp.

The solution of problems involving the selection of gear-tooth combinations for operation on crossed shafts is simple by the cut-and-try method, while for the solution of problems encountered in gear hobbing and gear shaving an attempt is made to clarify the

geometry involved. Because of the nature of the action of crossed helical gears, it seems desirable to discuss them in terms of pitch cylinders instead of pitch circles, base cylinders instead of base circles, and so on. Certain terms necessitate definitions differing somewhat from similar terms used with parallel shaft gears.

From author's summary

917. Stoner, T. A., and Sipek, C. B., Design of power spur-gear trains for minimum inertia, ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-8, 8 pp.

For utilizing motor torque fully, it is desirable in the design of a system that the ratio of the gear-train inertia and the load inertia be minimum.

Contrary to other authors [AMR **7,** Rev. 3163], in this paper the methods of designing power spur-gear trains for minimum inertia and approximate minimum inertia are described under assumptions that the pinions are equally stressed. The approximate method is useful because the presented curves for inertia ratios, in a logarithmic net, simplify selection of the number of gear meshes and afford a rapid estimation of the gear-train inertia.

A comparison between these methods and others is made.

See also: G. Thaler, R. Brown, "Servomechanism analysis," McGraw-Hill Book Co., Inc., New York, 1953, p. 36.

D. Rašković, Yugoslavia

918. Tank, G., Investigation of acceleration and deceleration of planetary gear trains (in German), *ZVDI* **96,** 10, 305–308, Apr. 1954.

An analytical determination is given of inertia forces appearing in planetary drives with two independent motors driving the sun gear and the planet carrier. Method applied is to calculate work of acceleration (or deceleration). Three cases are investigated: acceleration of carrier with the sun gear running at constant speed; acceleration of sun gear with carrier running at constant speed; and simultaneous acceleration of sun and carrier. Results of investigation are of interest in that they show in the third case the possibility of occurrence of stall of the carrier motor under certain conditions of loads and polar moments of inertia of gear-train components.

J. J. Dziewonski, England

919. Dietz, O., and Harling, R., Experiments on tail-wheel shimmy, *NACA TM* 1376, 81 pp., Oct. 1954. (Translation from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin, FB 1320, 1940.)

Model tests on the "running belt" and tests with a full-scale tail wheel were made on a rotating drum as well as on a runway in order to investigate the causes of the undesirable shimmy phenomena frequently occurring on airplane tail wheels, and the means of avoiding them. The small model (scale 1:10) permitted simulation of the mass, moments of inertia, and fuselage stiffnesses of the airplane and determination of their influence on the shimmy, whereas by means of the larger model with pneumatic tires (scale 1:2), more accurate investigations were made on the tail wheel itself. The results of drum and road tests show good agreement with one another and with the model values. Detailed investigations were made regarding the dependence of the shimmy tendency on trail, rolling speed, load size of tires, ground friction, and inclination of the swivel axis; furthermore, regarding the influence of devices with restoring effect on the tail wheel, and the friction damping required for prevention of shimmy. Finally, observations from slow-motion pictures are reported and conclusions drawn concerning the influence of tire deformation.

From authors' summary

Servomechanisms, Governors, Gyroscopics

(See also Revs. 902, 1117, 1118)

920. Smith, G. A., and Triplett, W. C., Experimental flight methods for evaluating frequency-response characteristics of aircraft, *Trans. ASME* **76,** 8, 1383–1390, Nov. 1954.

After a short review of basic equations of airplane motion, a derivation of the "short-period" pitch transfer function is given. Frequency response is obtained from measured transient response by evaluating Fourier integrals, using, e.g., Simpson's area rule, electronic harmonic analyzers, or other methods. Frequency spectra of several input types (triangle; rectangle; half, double, and triple sine wave) are shown and discussed. The analytical transfer function is derived from frequency response, using graphical methods in the Bode diagram. Result is checked with an analog computor which picks up the transfer function data and recalculates the transient. The latter is compared with the flight-test record and the coefficients are modified until sufficient coincidence is reached. Effects of speed and altitude variations are finally considered.

W. Oppelt, Germany

921. Demtchenko, B., Hydraulic regulation of the feeding of turbomachines (in French), *Publ. sci. tech. Min. Air, Paris* no. 277, 182 pp., 1953.

Report analyzes, in a systematic way, problems of control of fuel supply to propulsion engines, with special attention to jet engines. It consists of two parts, the first being devoted to the general theory of hydraulic supply circuits, and the second to treatment of specific problems.

General theory starts with systematic treatment of characteristic curves (i.e., relationships between rate of flow and loss of head) of throttling devices and means of obtaining different curves by coupling several throttles. Further, quantities to be controlled are reviewed, together with means of introducing signals into, and make them properly act upon, hydraulic circuits for fuel feeding. Special attention is devoted to the particular case when the supply must keep proportional to the product of two signals.

After reviewing basic operating characteristics of engines and control circuits. second part is devoted to principal control systems now in use.

Reviewer comments that text still shows, in some points, its derivation from work notes (as stated by author in preface); progress of treatment sometimes does not follow best logical order; mathematical developments are not up to possibilities allowed by modern theory of servomechanisms. On the other hand, the work as a whole shows remarkable qualities of insight and originality and marks a rational treatment which seems open to fruitful developments.

G. Evangelisti, Italy

Vibrations, Balancing

(See also Revs. 919, 971, 979, 980)

922. Saelman, B., Some notes on the dynamic load factor in simple undamped linear systems, *Amer. J. Phys.* **22,** 8, 563–567, Nov. 1954.

Dynamic load factor for a simple undamped linear system is defined as ratio of maximum reactic force to maximum applied force. It is shown that for an applied force, which is monotone, dynamic load factor cannot exceed 2; in particular, for a suddenly applied constant load its value is 2. For a sinusoidal force with the same frequency as natural frequency of the system, load factor is infinite. In practice, damping will reduce this value to

about 10. As illustrative example, load factor for a body falling onto a spring-supported platform is calculated. Its value is >2. Finally, load factor from a linear force is shown to be always smaller than load factor from a constant force.

R. Timman, Holland

923. **O'Callaghan, T., Calculation of torsional vibrations based on the theory of effective masses** (in German), ETH, publication Zürich, Prom. nr. 2140, 63 pp., 1953.

For the problem of determining the natural frequencies (or resonant frequencies) of systems capable of torsional vibrations, some thirty different methods have been suggested. For a survey, see one of the present reviewer's papers [AMR **3**, Rev. 1632]. One of the many methods is known as the method of "effective masses" or "equivalent masses." The underlying idea is that a system of many degrees of freedom may be represented by a two-mass system or a three-mass system, if the size of the representative masses (effective masses or equivalent masses) is made dependent on the frequency. The method has been suggested long ago and many papers have been written which made use of that idea. The author elaborates on the method and discusses various aspects of it. In fact, he discusses a number of the other methods in terms of the present one. K. Klotter, USA

924. **Klier, E., Extensional vibrations of circular quartz plates,** *Bull. Inter. Acad. Tchèque Sci.* **52**, 2, 479–495, 18 figs. (1951), 1953.

The contour modes of motion of a series of circular quartz plates has been investigated experimentally by measuring their frequency and by observing the surface motion by means of lycopodium powder. All motions found could be attributed to extensional, flexural, or shear modes or coupled modes of the fundamental vibrations. These frequencies are compared with those calculated by Dr. G. Cerná, who used Galerkin's method for obtaining the upper bound. Agreement within 3% for the first five modes is claimed, with 5 to 6% agreement for higher modes. Uses of these modes in controlling oscillator frequencies are discussed. W. P. Mason, USA

925. **Cicala, P., Design of tubes for maximum torsional frequency,** *J. aero. Sci.* **21**, 9, p. 646, Sept. 1954.

926. **Looney, C. T. G., Behavior of structures subjected to a forced vibration,** *Proc. Amer. Soc. civ. Engrs.* **80**, 451, 35 pp., June 1954.

Paper deals with modes of free vibration and the Müller-Breslau principle. A parallel is drawn between the behavior of a simply supported beam and a continuous structure whereby the similarity is shown between the shapes of the mode of free vibration, the influence line for deflection, and the influence line for bending moment.

For author's method of analysis see AMR **5**, Rev. 3030.

Reviewer considers that it would have been an advantage if the author had had the opportunity of using the more complete treatment of the problem which is to be found in V. Koloušek: "Baudynamik der Durchlaufträger und Rahmen," Fachbuchverlag GmbH, Leipzig, 1953. S. T. A. Ödman, Sweden

927. **McDowell, E. L., and Muster, D., A mathematical model of a rubber resilient mounting,** Proc. First Midwestern Conf. Solid Mech., Engng. Exp. Sta., Univ. of Ill., 175–179, Apr. 1953.

Transmissibility is obtained for lumped constant mounting with complex stiffness $K_0(1 + iR)$ where damping R is proportional to a power of the forcing frequency ω. Four technically important types of axially symmetrical rubber mountings are considered as continuum models carrying a single sinusoidally forced mass.

Authors show that transmissibility of continuum model can be expressed as a power series in μ and ω^2/ω_c^2, where μ is proportional to the ratio of the distributed mass to lumped mass, and ω_c is the resonant frequency neglecting distributed mass. Lumped constant result follows as limiting case for $\mu = 0$.

Neglecting terms in the series of $O(\mu^2)$ gives a quadratic in ω^2/ω_c^2. One root of this quadratic is close to Rayleigh's value for the mass correction of a lumped constant model, and the other gives a lower bound for the first wave resonance of the continuum model. C. T. West, USA

928. **Akün, F., Effect of the vibrations of machine tools on the smoothness of the machined surfaces** (in French), *Bull. tech. Univ. Istanbul* **4**, 1, 5–20, 1952.

According to author's summary: "The purpose of this study is to show the influence of machining vibrations on the surface finish of machined parts. Although the actual level of industrial technics permits the attainment of surface finishes up to highest technical requirements either by grinding, or, even more, by superfinishing technics, it is economically of greatest importance to obtain such a finish by machining without grinding. According to the results of this study, the roughness due to vibrations is chiefly produced by the radial component of vibration. Taking into account that the roughness due to vibration is of the same rate of numeric value as the roughness due to bad machinability, it is to be concluded that the machinability improvement should be considered as more important than the suppression of vibrations."

In his conclusions the author says: "The present results show that modern lathes actually employed cannot be blamed for the effect of their vibrations on the surface finish. According to the results, the roughness due to the vibrations while machining is nearly of the same numeric value as the one due to bad machinability (built-up edge in mild steel, graphite flocons in cast iron, etc.). . . This study shows that the most important points in lathe construction, as to their influence on the surface finish, are: (1) the broach bearings, which should be as precise as possible; (2) the tool post, as stiff as possible."

The reviewed article constitutes rather a summary or conclusions of a more detailed report, on the whole, of this important study [AMR **5**, Rev. 1110]. The variables listed which influence vibration are: machine tool (two different lathes), tool material (HSS 18-4-1, carbides of S1, S2, and G1 grade); material cut (mild and hard steel of undefined composition, and gray cast iron of 200 Brinell). Checking of other variables, such as cutting speed, feed per revolution, tool shape (especially nose radius), diameter turned, and tool overhang, may be assumed, but the range of experiments performed is not mentioned.

The incontestable merit of the paper rests in a very clear stressing of the greater importance of machinability vs. the machine-tool construction; further, in practical checking of mathematical formulas, expressing the rate of roughness as a function of radial, axial, and vertical vibrations. It should also be stressed that the author applied a very ingenious method of vibration checking, separately for the tool and for the pieces, in all three directions.

A. Niedzwiedzki, USA

929. **Stanišić, M. M., On the determination of the vibration angle for shrouded steam turbine blades at rest** (in German), *Forsch. Geb. Ing.-Wes.* (*B*) **20**, 4, 108–112, 1954.

From a comparison of theoretical and measured values of the vibration angle, it follows that the agreement is much better with a method based on the principle of least work than with an older

method of J. Geiger. The improvements are due to a better determination of the coupling term for the clamping moment, taking into account the mass of the turbine blade and observing that the angles of the force and the vibration do not coincide.

From author's summary by R. G. Boiten, Holland

930. Khvingiya, M. V., Small natural vibrations of constant-pitch conical springs (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **16,** 73–80, 1953.

The equation for free vibration of a conical spring is solved by transforming it into an ordinary form of the equation of vibration. Characteristics are given for cases where (1) both ends are fixed; (2) one end free and other end fixed. Their first two roots are tabulated. Formulas for frequency and integration constants corresponding to given initial conditions are obtained. Comparing with approximate formulas given by S. D. Ponomarev and A. V. Schtoda, the error and limit of application for approximate formulas are determined. M. Kataoka, Japan

931. Benjamin, T. B., and Ursell, F., The stability of the plane free surface of a liquid in vertical periodic motion, *Proc. roy. Soc. Lond.* (*A*) **225,** 1163, 505–515, Sept. 1954.

Authors consider the stability of the free surface of a non-viscous liquid contained in a generalized cylindrical container which is accelerated periodically along the axis of the cylinder. Acceleration (in the direction of the axis) and surface tension determine the stability of the surface. The Euler equations of motion with appropriate boundary conditions are linearized, and the velocity potential and the equation of the free surface are each expanded in terms of a complete orthogonal set of eigenfunctions. The values of the coefficients in the series solution are found to satisfy Mathieu's equation, the stability of which then determines the stability of the free surface.

The authors proceed to examine in detail the conditions for a rectangular and circular cylinder. What makes this paper particularly valuable is the fact that experimental tests were included as part of the investigation. The authors' experimental determination of a portion of the boundaries of the regions of stability check the theory within a few per cent for a circular cylinder. The small errors were ascribed to the neglected viscous action at the walls and the dissipation due to the surface tension effects at the wall and the free surface. R. S. Wick, USA

Wave Motion in Solids, Impact

(See also Rev. 979)

932. Tillett, J. P. A., A study of the impact on spheres of plates, *Proc. phys. Soc. Lond.* (*B*) **67,** part 9, 417B, 677–688, Sept. 1954.

Measurements of the coefficient of restitution have been made for the impact of steel balls on plates of glass and plastics. The times of contact have also been measured. The coefficient of restitution is found to be a function of the size of the specimen as well as of its elastic and anelastic properties. The variation in the value of the coefficient with the thickness of the specimen is in agreement with the theoretical variation derived by Zener. The value of the method of rebounding balls for an investigation of the anelastic properties of materials is discussed.

From author's summary by B. E. Gatewood, USA

933. Craggs, J. W., Wave motion in plastic-elastic strings, *J. Mech. Phys. Solids* **2,** 4, 286–295, June 1954.

Paper is concerned with longitudinal and transverse waves, and their interaction, in strings where the transverse motion is large enough to change the tension.

Under the assumption of a known "engineering stress-strain law," independent of the strain rate [i.e., $T = f(r)$, where T is the local tension in the strained state and r the ratio of stretched to original length of string element], equations of motion are derived. There result two quasi-linear hyperbolic equations, one for r or T and the other for ψ, the string slope. Associated with the first equation is the characteristic stress-wave velocity of propagation $c = [(1/m)T_r]^{1/2}$, where m is the mass per unit length of string (in original state). The second equation has associated with it the velocity $\lambda = (T/mr)^{1/2}$ for infinitesimal transverse waves.

Numerical methods for getting solutions to these equations are of prime concern to the author. One, based on the method of characteristics, is presented and discussed in connection with wave motion in a purely elastic string. Because of the complexities of this method in the case of a plastic-elastic string, author is led to a simpler finite-difference method of solution. Numerical results, obtained by this latter method for two examples involving pure longitudinal motion, are presented and discussed. Application of this finite-difference method to problems involving transverse waves is also considered. J. Miklowitz, USA

934. Blokh, É. L., Horizontal impact of an ellipsoid of rotation against an ideal fluid with an existing free surface (in Russian), *Prikl. Mat. Mekh.* **17,** 6, 705–726, Nov./Dec. 1953.

Reference is made to a former paper dealing with the horizontal hydrodynamic impact of a sphere. Impulsive compression is herein treated from the previous basic assumption, i.e., that the product of the velocity potential and the density of the liquid represents this compression. Elliptical coordinates μ, ζ, ω are used throughout with Laplace's equation for the velocity potential φ having the following appearance :

$$(\partial/\partial\mu)[(1-\mu^2)(\partial\varphi/\partial\mu)] + (1/1-\mu^2).(\partial^2\varphi/\partial\omega^2) = (\partial/\partial\zeta)[(1-\zeta^2)(\partial\varphi/\partial\zeta)] + (1/1-\zeta^2).(\partial^2\varphi/\partial\omega^2)$$

It is indicated that the solution of this equation, at least in the case of infinitely large values ($\zeta \to \infty$), can be expressed in terms of Legendre functions of the first and second orders, $P_n^m(\mu)$ and $Q_n^m(\zeta)$, respectively.

The cases considered in this paper are the following:

(1) An ellipsoid of rotation half immersed in an ideal liquid such that the plane of the minor axes is perpendicular to the major axis and that this plane coincides with the free surface of the liquid.

(2) An ellipsoid of rotation half immersed in an ideal liquid such that the plane of the minor axes is normal to the free surface of the liquid while the major axis is coincident with this surface.

(3) Interior cases: This treatment considers the ellipsoid to be filled with an ideal liquid rather than floating on its surface. The location of major and minor axes relative to the surface of the liquid is identical to cases (1) and (3).

(4) A compressed ellipsoid of rotation (oblate spheroid) half immersed in an ideal liquid with the free surface of the liquid coincident successively with the minor and the major axes (analogous in solution to cases (1) and (2)). N. M. Matusewicz, USA

935. Schlaefke, K., On force-deflection diagrams of airplane shock absorber struts. First, second, and third partial reports, *NACA TM* 1373, 48 pp., Nov. 1954 (translation of *Technische Berichte* **11,** nos. 2, 4, 5, 1944).

Reports, orginally published in 1944, present methods of analyzing airplane shock-absorber struts considering linear and compressed-air springing, and linear and quadratic damping. The

effects of tires and metering pins are not considered. Figures presented show the effect of nonlinearity in a number of cases.
S. Levy, USA

Elasticity Theory

(See also Revs. 925, 934, 952, 954, 963, 964, 966, 1004, 1177)

936. **Green, A. E., and Wilkes, E. W., Finite plane strain for orthotropic bodies,** *J. rational Mech. Analysis* **3,** 6, 713–723, Nov. 1954.

Authors solve the problem of flexure of a cuboid for compressible orthotropic materials. Also, compressible material with transverse isotropy with respect to a fixed direction is considered. The solution is established for finite extension and inflation of a hollow cylinder of compressible material with transverse isotropy.
W. Ornstein, USA

937. **Higuchi, M., On the axisymmetric boundary-value problems in the transversely isotropic elasticity theory,** *Rep. Res. Inst. appl. Mech. Kyushu Univ.* **3,** 11, 143–145, Aug. 1954.

938. **Adkins, J. E., Some generalizations of the shear problem for isotropic incompressible materials,** *Proc. Camb. phil. Soc.* 50, part 2, 334–345, Apr. 1954.

A thick-walled tube of homogeneous isotropic incompressible elastic material is bonded to a rigid liner inside and sheath outside (as in a type of vibration isolator). Liner is held, sheath given finite axial displacement. This problem is solved for a Mooney material, for circular bounding curves, concentric and eccentric, and for confocal ellipses. End effects remain, as in small deformation. Plane shearing deformation is also worked out. In each case an assignable uniform axial extension is included. These are special problems in general theory given for displacements in z-direction only, which is function f of x, y only (cf. Saint Venant warping displacement), combined with displacements of simple z-extension and lateral contraction. Fundamental nonlinear equations are in Rivlin Cartesian form neatly condensed by index notation. The differential equation for f becomes linear (Poisson's eq.) on introduction of Mooney material, thus allowing substantial contribution to final solutions of special problems.
J. N. Goodier, USA

939. **Sneddon, I. N., Some solutions of equations of motion of an elastic solid** (in French), *R. C. Circ. Mat. Palermo* (2) 3, 1, 115–129, 1954.

Author sketches the application of the method of integral transforms (Fourier and Hankel) to two classes of problems in elasticity: the stress distribution due to surface traction and that due to body forces. Special cases worked out by the author, which will soon be published, are summarized and classified. These include:

(1) Three-dimensional infinite solids under unidirectional body forces of the following types: static three-dimensional distribution, two-dimensional distribution but time-varying harmonic in time, delta function and unit-step function in time, and concentrated load moving at uniform speed.

(2) Infinite solids under axisymmetrical body force acting in the axial direction, either a delta function of time or a moving load.

(3) Semi-infinite solids under variable surface tension and surface shear, with the same variations in time as in case (1).

(4) Semi-infinite solid under varying body force.

(5) Semi-infinite solid under axisymmetric surface traction or shear or body force.

(6) Large plates under varying surface traction, both in two-dimensional distribution and in axisymmetric cases.

(7) Long cylinders and tubes under varying surface pressure.
Y. C. Fung, USA

940. **Birman, S. E., Plane problem of solids composed of parts having different elastic constants** (in Russian), *Doklady Akad. Nauk SSSR (N.S.)* **93,** 6, 989–992, Dec. 1953.

941. **Levi, R., Application of probability theory for calculation of strength** (in French), *Ann. Trav. publics Belg.* **106,** 2, 175–204, Apr. 1953.

Author proposes to interpret the safety factor in terms of probability. Let R and P be the strength and the load, respectively. Then $\log R$ and $\log P$ are assumed to be independently and normally distributed, their means, $\log Ro$ and $\log Po$, as well as their standard deviations, α_R and α_P, being known empirically. Rupture occurs when $\log R - \log P$ becomes negative. In order that it should happen only with probability 0.5×10^{-6}, we must take $\log (Ro/Po) = 4.89\,(\alpha_R^2 + \alpha_P^2)^{1/2}$. This will give an adequate safety factor Ro/Po, which reasonably depends on α_R and α_P. Thus the safety factor should be reduced as the material becomes more uniform. For stable loads, the safety factor may be lower than for more variable loads.
S. Moriguti, Japan

942. **Miyamoto, H., Stress concentration around a heterogeneous insertion of spheroid in an elastic body. Part III,** *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 43–46.

Spheroidal coordinates are used to obtain H. Neuber's solution of the stress concentration around a prolate or oblate spheroid in an infinite body subjected to torsion about its axis. The first paper [AMR **5,** Rev. 592] contained the general solution for the tension problem.
B. R. Seth, India

943. **Miller, K. A. G., The design of tube plates in heat exchangers,** *Instn. mech. Engrs. Proc.* (*B*) **1B,** 6, 215–227, 1952.

Derivations are presented which lead to design formulas for calculating stresses or thickness of heat-exchanger tube plates, due to both pressure and (where applicable) differential-temperature loading. Method is based on small-deflection thin circular-plate theory, but, unlike method in common use, accounts for elastic-foundation support of tubes. In addition, weakening effect of holes is introduced by modifying stresses and flexural rigidity by a simple area-ratio "efficiency," shown by author to agree with empirical range suggested earlier by Gardner for same purpose [*J. appl. Mech.* **15,** p. 377, 1948].

Complete results for box, floating-head gland, and hairpin types of heat-exchanger construction are derived and are tabulated in easy-to-use form. Experiments on one type of heat exchanger yielded strains and stresses in moderate agreement with theory; present equations showed up distinctly better than older, simpler ones.

Reviewer feels method should be of considerable interest and usefulness to designers in this field.
M. S. Silberstein, USA

944. **Miller, D. R., and Cooper, W. E., Structural problems of a sodium-cooled nuclear reactor,** ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-75, 19 pp., 2 figs.

The general configuration and structural loading characteristics of a sodium-cooled nuclear power reactor are described. Of particular importance are the effects of internal heat production in solids and the steady-state and transient thermal stress problems.

An approach to evaluation of structural design quality and the stress limitations to be imposed on various loadings are also discussed. From authors' summary by H. T. Corten, USA

945. Gatewood, B. E., Thermal loads on joints, *J. aero. Sci.* **21,** 9, 645–646, Sept. 1954.

When two bars of different materials are bolted or riveted together and subjected to a temperature change, or two bars of the same material are subjected to different temperature changes, the bolts must take loads to hold the bars together. This paper investigates the loads on the rivets or bolts when their deflection is considered. From author's summary

946. Hieke, M., On a problem of discontinuous thermal stresses in the plane (in German), *ZAMM* **34,** 4/5, 121–139, Apr./May 1954.

Paper deals with the following problem: The wedge $|\varphi| < \varphi_0$ of a circular cylinder of infinite length and radius r_0 (r, φ, z . . . cylindrical coordinates) is kept at constant temperature while the remainder is kept at zero temperature. Temperature is independent of z and cylinder is in state of plane strain. Solution of classical equations of elasticity is given in terms of Airy's stress function, $F = V - W$, where V is a biharmonic function and W represents the thermoelastic potential. On the boundary, $F = 0$ and $\partial F/\partial r = 0$.

First the temperature distribution is represented in terms of Dirichlet's discontinuous integral. From that, W is obtained which, in turn, furnishes the boundary values for V and $\partial V/\partial r$. By interchanging order of integration in double integrals, the solution is then obtained in closed, though rather unwieldy, form. (Reviewer's note: The way in which the symbol T is used throughout the paper may cause some confusion. It denotes the temperature distribution, as well as some constant, both at the same time.) Finally, stress distribution is studied and some numerical evaluation is given. Normal stress σ_r experiences a jump along the surface of discontinuity of temperature. (Reviewer's note: This has been shown to be a general property of fields of thermal stress by J. N. Goodier, *Phil. Mag.* **7,** 23, 1017, 1937.)

The paper is prefaced with a discussion of some well-known facts about compatible (Kirchhoffian) and noncompatible strain tensors. No mention is made here of the paper by H. Reissner [title source, **11,** 1, 1–8, 1931]. H. Parkus, USA

Experimental Stress Analysis

(See also Rev. 1244)

947. Johnson, A. E., Jr., Bending tests on box beams having solid- and open-construction webs, *NACA TN* 3231, 25 pp., Aug. 1954.

Experiments were made on the effects of replacing alternate webs in a multiweb beam by open, post-stringer construction. The beams were loaded in pure moment and the critical buckling and failing stresses recorded. Results indicate that posts are comparable to the solid webs in stabilizing the compression cover. H. H. Dixon, USA

948. Thurlimann, B., and Johnston, B. G., Analysis and tests of a cylindrical shell roof model, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. 434, 29 pp., Apr. 1954.

The following problems are discussed:

1 The supporting ribs in cylindrical shell roofs can be designed as T-sections, utilizing a portion of the shell as the flange. The effective width of flange depends on (a) shear lag as in a flat slab and (b) the radial displacement of the shell due to the circumferential forces in it.

2 Stresses due to horizontal external forces parallel to the longitudinal axis of the roof.

3 Stresses due to foundation movements.

4 Stresses due to temperature changes and to shrinkage. Results given are based on analysis verified by tests on a model of approximate scale $^1/_{30}$. M. P. White, USA

949. Vida, K., Photoelastic investigation of nonhomogeneous foundations (in German), *Bauingenieur* **29,** 9, 350–352, Sept. 1954.

Author shows that the stress distribution of plane deformation in a nonhomogeneous semi-infinite body can be studied with two-dimensional photoelasticity by using a homogeneous model of variable thickness. H. Favre, Switzerland

950. Polzin, M. H., Performance evaluation of a magnesium alloy truck wheel, *Proc. Soc. exp. Stress Anal.* **11,** 1, 65–80, 1953.

Rods, Beams, Cables, Machine Elements

(See also Revs. 916, 917, 962, 967, 968, 984, 987, 989, 990, 1026)

951. Cheng, D. H., and Pei, M. L., Continuous deep beams, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 450, 17 pp., June 1954.

Previous solutions of problem have implied longitudinal displacement of supports. Authors present solution for continuous beams on equally spaced supports with no displacement of supports. Loading is symmetrial at top or bottom of beam or by its uniform weight. Stress function and hence normal and shear stresses are expressed by infinite series of circular and hyperbolic functions. Expressions for constants to meet the boundary conditions are given for uniform, partial uniform, and point loads applied at the top edge or the bottom edge. For the various loadings, curves are provided for bending stresses at midspan and at the supports for height-span ratio of unity. Shear stress curves are given at the quarter span section for several loading conditions.

This, together with other recent work on stresses in deep beams [AMR **5,** Revs. 1029, 3056], should be of value to designers. C. M. Tyler, Jr., USA

952. Volterra, E., Deflections of a circular beam out of its initial plane, *Proc. Amer. Soc. civ. Engrs.* **79,** Separ. no. 375, 22 pp., Dec. 1953.

In this paper solutions in explicit forms are given of problems of deflections of circular beams subjected to uniformly distributed forces and supported at symmetric points, and of the deflections of circular-arc bow girders acted on by distributed or concentrated forces. For solution of the problems, the Saint Venant equations [*C. R. Acad. Sci. Paris* **17,** pp. 942, 1021–1031, 1843] have been used. The curves and the tables of the results obtained will be helpful to engineers. S. C. Das, India

953. Kubo, G. G., Johnston, B. G., and Eney, W. J., Nonuniform torsion of plate girders, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 449, 28 pp., June 1954.

Present torsion theory consists essentially of three branches, namely, the uniform unrestrained-warping torsion of Saint Venant, the nonuniform restrained-warping torsion of Timo-

shenko, and the more general treatment of the same by Goodier and Barton. The present paper deals with an experimental investigation of the nonuniform torsion of plate girders to compare theoretical predictions with experimental observations and to determine modifications indicated for built-up sections.

Details of test procedure are given in the paper.

Eight conclusions were reached for rolled beams in which end restraint prevented full warping, the more important of which may be summarized as:

The Timoshenko solution is adequate for predicting stress magnitudes for the usual rolled sections and for plate girders with a relatively high web-to-flange thickness ratio. It errs appreciably on the low side in predicting flange stresses in heavy flanged plate girders.

The Goodier-Barton theory adequately predicted flange bending stresses in plate girders tested, and also the effect of web deformation on angle of twist of cantilever girders.

In general, for design purposes the simpler Timoshenko solution is probably adequate; for more precise results the Goodier-Barton theory is required. F. S. Shaw, Australia

954. **Sonntag, R., Formula to compute the maximum shear stresses due to pure torsion at the transition points of stepped shafts** (in German), *ZAMM* **34,** 1/2, 19–36, Jan./Feb. 1954.

Starting with the exact solution of the torsion problem for a shaft with a circular groove in circumferential direction, author obtains simple and reliable formulas for the stress concentration at the fillet for many variations of stepped shafts under pure torsion. The method is also applied to the problem of a shaft with a key slot in longitudinal direction. F. M. Mueller, USA

955. **Olsson, U., Non-circular cylindrical gears,** *Acta Polyt.* no. 135, *Mech. Engng. Ser.* **2,** no. 10, xi + 216 pp., 1953.

Book gives a method for the design and construction of gears of arbitrary form that produce a variable gear ratio. It is divided into two parts: (1) study of suitable forms for the pitch curves, their generation, and their geometry; (2) study of the cutting of gears having as pitch curves the aforesaid curves.

Author's method consists in substituting approximately any pitch curve with a certain number of arcs of "conic section rolling curves" (*csr* curves), that is, curves mating to curves of the second degree rotating about one of their foci, radii and slopes being maintained at the ends of every arc.

The fulfillment of these four conditions in every case requires also the consideration of curves formally mating to curves of the second degree with certain complex parameters.

As the mating curve to a *csr* curve is seen to be also a *csr* curve, both the rolling curves are composed with arcs of *csr* curves. The mathematical study of every possible *csr* curve and of the substitution in every case of an arbitrary pitch curve with arcs of *csr* curves is developed in part 1 with particular care and detail and occupies the greatest part of the book (pp. 26–124). The many final formulas are collected in appendixes. Some numerical examples are also developed.

In part 2, author calculates, for pitch curves composed with *csr* curve arcs, the geometrical data required for cutting with milling cutters; special attention is given to elliptical rolling curves; also some methods of cutting elliptical gears by generation are briefly described.

Some examples of constructed noncircular gears are reported. The possibility of extending the previous theory to conical gears is indicated.

The book has 18 appendixes containing schemes of calculations, curves, and numerical data for an easy application of the theory and concludes with a bibliography of 77 references.

Reviewer believes that this book constitutes an original and valuable contribution to the theory and practice of noncircular gears. R. Giovannozzi, Italy

956. **Wrigley, C. C., The solution to finding the exhaust valve cone angle for a ball in the dynaflow transmission,** *GM Engng. J.* **1,** 5, p. 52, Mar.-Apr. 1954.

957. **Stallings, H. B., The electromagnetic clutch—its operation, application, and control,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-9, 10 pp.

The electroclutch is a relatively new device which, in a very short time, has changed the basic concept of many machine tools and other machines using gear boxes for power transmission. Speed changes now can be made with great ease either by manual or automatic control. From author's summary

958. **Oktavec, Computation of the dynamic roughness of reciprocating engines with allowance for the elasticity of the shaft** (in German), *Maschinenbau-Technik* **3,** 1, 13–19, Jan. 1954.

Plates, Disks, Shells, Membranes

(See also Revs. 924, 932, 943, 948, 972, 973)

959. **Dean, W. R., Note on the Green's function of an elastic plate,** *Proc. Camb. phil. Soc.* **50,** part 4, 623–627, Oct. 1954.

Author considers an elastic plate of infinite extent, clamped along an internal elliptic boundary. He then computes, within the framework of thin-plate theory, the transverse displacement of the plate due to a concentrated load, normal to the plate, applied at an arbitrary point. H. Deresiewicz, USA

960. **Trenks, K., Contribution to the calculation of orthogonal anisotropic rectangular plates** (in German), *Bauingenieur* **29,** 10, 372–377, 1954.

A small-deflection theory is presented for rectangular, orthotropic plates, loaded perpendicular to their plane. The differential equations, derived by Pflüger, who considered plates loaded in their plane, are taken as a starting point. By eliminating the displacements in the plane of the plate, a differential equation of the eighth order for the deflections is obtained. The only limitation of the theory lies in the (unnecessary) assumption that the stiffeners have no torsional rigidity.

An extensive comparison is made between the results of the general theory and of the approximate method, introduced by Huber. The differential equation of the fourth order for the deflections, used by Huber strictly holds only if the center-of-gravity lines of the stiffeners lie in the mid plane of the plate. It is shown that, nevertheless, a good approximate solution may be obtained by means of this differential equation, provided that the torsional rigidity of an element of the plate, occurring in the second term of the equation, is multiplied by an appropriate factor. In case the plate has stiffeners in only one direction, a very close approximation of the deflections and the stresses is found, simplifying the general theory by neglecting the displacements in the plane of the plate perpendicular to the direction of the stiffeners. J. F. Besseling, Holland

961. **Neman, I. G., Stability of an infinitely long isotropic plate compressed transversely and longitudinally, and also sheared** (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **15,** 73–82, 1953.

The constant, distributed compressive and shearing loads act

in the plane of the plate described in the title. Stability of such a plate was analyzed before by H. Wagner in "Über Konstructions und Berechnungsfragen des Blechbaues" [Jahrbuch der Wissenschaftlichen Gesellschaft für Luftfahrt, T.V. 113/1125, 1928], who presented approximate formulas without showing how he obtained them. Wagner's formulas are not very reliable as they give, in certain cases, imaginary values for shearing loads.

The author solves the problem for two boundary conditions: (a) the longitudinal sides simply supported, (b) the longitudinal sides fixed. He solves the partial differential equation of equilibrium by separation of variables, gets the expressions for loads, minimizes them, and obtains critical loads. Numerical tables of critical loads for various mutual ratios of loads acting in different directions are given at the end. The results are compared with those of Wagner and give a fairly good agreement for sides freely supported, but disagree completely for the sides fixed. [NOTE: Fig. 1 in the paper is printed upside down.]

T. Leser, USA

962. Christopherson, D. G., and Higginson, G. R., The strength of short cylinders under internal pressure, *J. Mech. Phys. Solids* **2,** 4, 217–237, June 1954.

Paper outlines method of evaluating the limiting strength of short tubes under internal pressures, with ends radially constrained—both simple and clamped conditions (one and/or both ends) considered. The energy theory, using the total strain (deformation) theory, rather than the mathematically correct incremental strain (flow) approach, adopted for this problem, gives remarkably close agreement with experimental results and is based on the von Mises flow criterion. The elastic strains are neglected. Possibility of allowing for the effect of material work-hardening is shown. The technique employed in this paper is useful as a design criterion.

Z. W. Dybczak, Canada

963. Jackson, R. L., and Johnson, L. H., Design of steam-piping systems for large central-station applications, ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-59, 6 pp.

964. McComb, H. G., Jr., Stress analysis of circular semi-monocoque cylinders with cutouts by a perturbation load technique, *NACA TN* 3200, 37 pp., Sept. 1954.

The infinitely long cylinder has 36 identical stringers, equally spaced. The ribs are equally spaced and infinitely stiff against normal forces and bending in their planes. The shell plating between stringers and ribs carries only shear stresses. Formulas, already derived by the author in AMR **8,** Rev. 619 (in which the ribs may have a finite stiffness against bending), are used to calculate a set of tables in which is given the stress distribution caused by a unit load applied in stringer direction at the intersection of a stringer and a rib. The same is done for two other elementary types of loading. Five values for the ratio AR/tL^2 are used (A is cross-sectional area stringer, R radius cylinder, t shell plating thickness, L rib distance). For other numbers of stringers it is recommended that they be replaced by an equivalent set of 36 stringers.

By means of these solutions, the perturbation in the stress distribution may be calculated if, in the structure, a cutout is made with reinforcing structural elements in the neighborhood of the cutout. A numerical example for a structure under a constant bending and torsional moment is given.

Paper, together with AMR **8,** Rev. 619, forms the generalization of AMR **7,** Rev. 62, in which $R = \infty$.

J. P. Benthem, Holland

965. Layrangues, M., Statics of thin shells by the method of vector analysis. Part II (in French), *Ann. Ponts Chauss.* 124, 1, 27–67, Jan.-Feb. 1954.

Author derives the equations of equilibrium for thin shells using Cartesian coordinates. Here too, as in part I [title source, no. 5, Jan.-Feb. 1953], only the extensional deformation is regarded. The equations are derived for the general surface $z = F(x, y)$ and the surface $z = g(x) + h(y)$. Explicit and numerical solutions for different boundary conditions are given for the shells defined by $z = (x^2 + y^2)/2a$, $z = (x^2 - y^2)/2a$, $z = x^2/2a + x^2/2b$. Finally, the conoide $z = xy(y)$ is studied for $g(y) = 1 - y^2/a^2$ and $g(y) = (1 - y^2/a^2)^{1/2}$.

J. W. Cohen, Holland

966. Nakamura, K., Stresses and displacements in a rotating ring shell, *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 87–92.

Stresses and displacements are calculated in a rotating ring shell, the middle surface of which is generated by revolving a circular arc about a tangent line. Numerical results have been obtained and compared with those of J. L. Meriam who used the differential analyzer.

B. R. Seth, India

Buckling Problems

(See also Rev. 1002)

967. Poley, S., Lateral buckling of cantilevered I-beams under uniform loads, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 527, 6 pp., Oct. 1954.

Author has calculated the elastic buckling strength of doubly symmetrical I-section cantilever beams, subjected to uniform transverse loading applied at the neutral axis. The solution is expressed in terms of finite differences, and numerical results have been obtained with the aid of an IBM Card Programmed Calculator. Values of the buckling constant m are tabulated for various values of the ratio L/a ranging between 1.0 and 10.

J. W. Clark, USA

968. Engelhardt, H., Common treatment of rod buckling taking into account the weight of the rod, and the "Euler cases" 1–4, as eigenvalue problems (in German), *Stahlbau* **23,** 4, 80–84, Apr. 1954.

Author shows how the weight of the rod can be taken into account in the "Euler cases" of buckling in a very easy way. Paper gives exact solutions and approximation methods according to Collatz (Rayleigh, Ritz-Galerkin, Dunkerley procedures of iteration), information about bound of errors, and formulas for practice.

In concluding part, a comparison is made with corresponding DIN 4114 formulas for a linearly increasing axial load of the rod.

From author's summary by H. F. Long, Argentina

969. Katsuta, C., High speed buckling of mild steel columns, *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 65–68.

Paper reports on the results of experimental and theoretical studies on high-speed plastic and elastic buckling of mild steel columns. For short columns under high-speed compressive loading, it was found that the dynamic yield values were higher than the static values and the increase could be expressed as a function of the loading velocity.

Author then considered the buckling of columns which, though fairly long, yielded plastically before buckling elastically. It is

stated that "high-speed plastic buckling values are theoretically derived." However, no theoretical derivation is shown. Some theoretical curves are compared with experimental points and the agreement is good.

For the case of very long columns, elastic buckling occurred before yield. An abbreviated theoretical treatment is included. This consists of listing a solution of the equation of vibration of a column. Some of the symbols used are not defined and the reviewer was not able to find out what the solution means. Theoretical curves are compared with experimental points and agreement is fairly good. Again, author does not define some of the symbols he uses. For example, loading velocity is defined as t/cm^2 sec with no hint of what t might be. Y.-H. Pao, USA

970. **Miyagawa, M., On buckling rupture of columns,** *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 47–52.

Problem considered is the progressive deflection of long columns with initial deflection under axial compressive load. The axial load is lower than the elastic static buckling load, and the progressive nature of the deflections is due to creep.

It is assumed that the total strain in tension can be considered to be the sum of an elastic strain and a steady-rate creep strain, and that rupture takes place at a certain creep strain. It is further assumed that the relation between bending moment M and the rate of change of curvature due to creep $\dot{\eta}_c$ are just the same as the stress σ and the creep rate $\dot{\epsilon}_c$ for tension creep, rupture in bending occurring when the curvature arrives at a limiting value which is presumably obtained from tension data.

An approximate solution is obtained by assuming that the shape of the column remains sinusoidal as in the linear elastic case, even though the differential equation is now nonlinear.

The entire treatment of the problem follows very closely that of J. Marin [*J. appl. Phys.* **18,** no. 1, 1947]. The only difference lies in the additional assumption concerning rupture. In the opinion of reviewer, the problem of collapse can be treated without any additional arbitrary assumption concerning rupture.

Y.-H. Pao, USA

971. **Bolotin, V. V., Dynamic stability of plane bending** (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **14,** 109–122, 1953.

The lateral buckling of a narrow strip of rectangular cross section acting as a beam and subjected to pure bending around the strong axis is considered in this paper. The applied end moments are assumed to be $M = M_0 + M_t \cos \theta t$, i.e., they vary sinusoidally with time. Then, since M is a time-dependent function, inertia terms are contributed to the appropriate differential equations by the lateral displacement as well as by the twisting of the strip.

Author assumes simply supported conditions at the end of the beam and, by separating the variables, obtains a system of ordinary differential equations with periodically varying coefficients. Employing matrix notation, most of the paper is devoted to the study of the behavior of these equations. At the end of the paper, by means of examples, the behavior of beams with more complex cross sections is discussed. E. P. Popov, USA

972. **Johnson, J. H., Jr., Critical buckling stresses of simply supported flat rectangular plates under combined longitudinal compression, transverse compression, and shear,** *J. aero. Sci.* 21, 6, 411–416, June 1954.

Critical combinations of shear and longitudinal and transverse compression for simply supported flat rectangular plates are presented in two forms: first, as tables and charts of shear buckling coefficient K_s vs. plate aspect ratio a/b ($1.0 \leq a/b \leq 4.0$) for various values of longitudinal and transverse compressive buckling coefficients K_x and K_y; second, as charts of K_x vs. K_s for various values of K_y/K_s and aspect ratio. Rayleigh-Ritz method and matrix iteration were used to obtain results, which are believed to be within 1% of exact values.

P. Seide, USA

973. **Shibuya, I., Buckling of an elliptic cylinder under torsion,** *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 53–58.

The problem considered is the torsional buckling of a thin-walled elliptic cylinder with no end constraint. Taking into account the change of the curvature, especially in the vicinity of the ends of the minor axis, it is found that the cylinder buckles under a stress lower than that calculated on the basis of the original shape of the cross section. Y.-H. Pao, USA

Joints and Joining Methods

(See Revs. 945, 983, 1018, 1024)

Structures

(See also Revs. 926, 944, 948, 949, 1002)

974. **Gravina, P. B. J., The process of compensation of displacements. Contribution to the theory and analysis of frames** (in Portuguese), *Escola Politécn. Univ. São Paulo, Brasil, Publ. Cadeira Pontes grand. Estrut.* no. 20, 77 pp., 1953.

Following Guldan's exposition and notation [*Rahmentragwerke*], author repeats resolution of elastic systems with orthogonal bars, using joint rotations as unknowns and solving the corresponding equations by continuous iteration. A comparison is made with methods of Cross and of Kani for systems with and without sidesway, concluding that author's is clearer and more convenient than these latter two. Reviewer shares this conclusion.

Author then proposes to use as unknowns joint rotations, employing as fundamental system that in which only joint rotations are prevented, permitting joint translations. This method, previously proposed by Luetkens in his "Rahmenstatik" (p. 9), is now developed by author, who separates unknowns in two groups so that each of them is surrounded by components of the other group. No reason is given for this artifice, which, in reviewer's opinion, must not necessarily improve convergence. The work closes with the numerical solution of some examples.

Reviewer makes the following observations: (1) Author carries out numerical operations over a structure sketch, which is not practical, as the figures inserted in the work prove it is better to work in the form of a numerical table. (2) A Vierendeel truss is not a good example to solve with joint rotations and translations as unknowns, because better precision and less material work indicate the use of forces as unknowns. (3) There are several typographical mistakes that make it difficult to follow the examples.

A. J. Bignoli, Argentina

975. **Gravina, P. B. J., Contribution to the theory of continuous frames. An analytical method for the calculation of influence lines** (in Portuguese), *Escola Politécn. Univ. São Paulo, Brasil,* 1950, 64 pp.; *Engenharia* **8,** nos. 93, 94.

The particular case of frames with one horizontal girder and several vertical posts is considered by author for calculating influence lines of M, N, and Q in different sections, following Guldan's method [see *Rahmentragwerke*]. After repeating the

calculation of the inverse matrix by the Banachiewicz method (Cracovians), author obtains influence lines using inverse matrix, in the usual manner [see, e.g., K. Beyer, p. 167]. A complete numerical example is given.

Reviewer observes: (1) That Eqs. 26, 27, 28, and 29 can be established in a more direct and simple manner by superposition of deformations; (2) Fig. 4 on page 18 corresponds to an impossible deformation of frame. In reviewer's opinion, this work has only didactic value, as a good exposition of very well-known facts.

A. J. Bignoli, Argentina

976. Readey, W. B., Optimum design of indeterminate frames, *J. aero. Sci.* **21,** 9, 615–620, Sept. 1954.

Author defines the optimum design as one which results in constant strains (due to bending only) in the extreme fibers of compression and tension caps, but the tension and compression strains are not necessarily equal. Due to constant strain throughout the frame, the location of inflection points can be determined without knowing exact loading, provided the number of inflection points is specified. With a chosen constant strain, the optimum section properties of the frame subject to a given loading may be determined when the inflection points are located. As an example, the inflection points of a symmetrically loaded ring of uniform depth, having four inflection points, are shown to be located at 90° intervals. The determination of optimum section property of an unsymmetrically loaded simple frame is also illustrated. Both numerical examples are solved by iteration.

Although the derivation of equations implies elastic material, author claims they should be valid also in plastic range. In conclusion, author suggests the method may be useful for preliminary weight estimate. D. H. Cheng, USA

977. Horridge, J. F., Portal frame analysis by moment area methods, *Struct. Engr.* **32, 8,** 215–222, Aug. 1954.

The method presented here is applicable only to portal frames with hinged base columns, but as about 80% of every-day portal design comes under this category, it must be agreed that this fact does not seriously affect its usefulness to the designer.

The method is a "true" one—that is, as "true" as Mohr's moment area theorems—and does not require any approximations or trial-and-error calculations. It can be used for the solution of portal frames of any number of varying spans, and with deck beams (or rafters) and columns of varied inertia and elasticity.

Several examples are given, including a 4-bay structure with asymmetrical loading. From author's summary

978. Merchant, W., The failure load of rigid jointed frameworks as influenced by stability, *Struct. Engr.* **32,** 7, 185–190, July 1954.

979. Hudson, D. E., Alford, J. L., and Housner, G. W., Measured response of a structure to an explosive-generated ground shock, *Bull. seism. Soc. Amer.* **44,** 3, 513–527, July 1954.

Measurements were made of ground accelerations and the resulting accelerations at a point very near a large quarry blast. It is shown that, in the case of simple buildings, the building acceleration may be calculated with satisfactory accuracy from a knowledge of the ground acceleration.

The response of the test building to the ground acceleration of a typical strong-motion earthquake was computed, and it was found that the resulting accelerations were in excess of those usually provided for the earthquake-resistant design. It is concluded that the satisfactory performance of well-designed structures during strong earthquakes may have two explanations: (1) That vibration energy is dissipated by stresses in excess of the elastic limit, with the result that hidden damage may occur; (2) that ordinary buildings may have sources of strength which are not taken into account in their design.

From authors' summary by K. Kasahara, Japan

980. Nishimura, G., and Suzuki, M., Horizontal deformation of a Japanese two-storied frame-house: (1) Vibration due to an arbitrary shock, (2) vibration caused by a rotary with unbalanced mass, (3) vibration due to natural wind, and (4) deformation due to the sun's radiation heat, *Bull. Earthq. Res. Inst., Tokyo Univ.* **32,** part 1, 113–114, 3 plates, Mar. 1954.

Paper explains the vibration properties of a Japanese two-storied wooden house when it is subject to free vibration caused by a shock, and also to forced vibration due to unbalanced force or natural wind pressure. The house deformation due to thermal stress under the radiation heat of the sun has also been studied.

From authors' summary

981. Hanrahan, F. J., Glued laminated timber construction, *Southern Building* **4,** 11–13, Nov. 1954.

The author, as representative of the American Institute of Timber Construction, describes the present status of one of the principal products of the members of this Institute, namely, glued laminated timber structures. Such structures include beams with spans of more than 100 ft, arches with spans of more than 200 ft, and trusses with spans of more than 250 ft. The advantages of this type of construction are presented, with references to previous outstanding publications in this field, including the recently published Timber Construction Standards of the Institute.

E. G. Stern, USA

982. Salgo, M. N., Examples of timber structure failures, *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no. 544, 19 pp., Nov. 1954.

Based on the author's 15-years' experience with timber structures, an analysis is presented of outstanding major structural failures of split-ring connectored timber structures which occurred during the past 10-year period. To eliminate even the few failures on which reports have been received, author makes seven suggestions concerning improvements for design, erection, and maintenance of timber structures. E. G. Stern, USA

983. Anonymous, Glued timber structures, *Wood* **19,** 11, 442–445, Nov. 1954.

A comparison is made between nailed, screwed, bolted, connectored, and glued joints for roof trusses. Test data are presented for glued joints loaded in single and double shear, with the glue-setting pressure obtained by using nails driven into prebored holes. E. G. Stern, USA

984. Zwoyer, E. M., and Siess, C. P., Ultimate strength in shear of simply-supported prestressed concrete beams without web reinforcement, *J. Amer. Concr. Inst.* **26,** 2, 181–200, Oct. 1954.

Reports on 34 simply supported prestressed concrete beams without web reinforcement. Beams had rectangular cross section and bonded straight wires. Chief variables were percentage of steel and unit prestress, concrete strength, and ratio of shear-span to beam depth. Diagonal tension failures were characterized by diagonal cracks followed by crushing at the load point in the zone above these cracks. Paper calculates nominal unit shear stresses but otherwise ignores this approach. Final failure is analyzed as a premature compression failure induced by diagonal cracks that rise higher in the beams than moment cracks. Necessary parameters are evaluated from observed ultimate moment

and observed location of neutral axis. Scatter of data raises some doubts as to accuracy of these functions, but actual ultimate moments correlate closely with final equation showing $M_{ult} \div bd^2$ as a function of prestress and steel percentage. This equation holds only when diagonal cracks have formed. An attempt to define the boundary between this type failure and failure in true flexure was only partially successful.

A similar study of other data for rectangular beams without prestress failing in shear led to $M \div bd^2$ as a function of percentage of steel and percentage of stirrup steel. Increase in stirrups or in prestress leads to higher ultimate moments, but always to moment smaller than might be calculated for a flexural compression.

This new concept of shear (diagonal tension) failure as a premature moment failure has significant possibilites. Direct use of this type analysis awaits development of criteria to determine which type of failure—shear or flexure—will occur for a particular beam and loading. P. M. Ferguson, USA

985. **Tachau, H., and Mostafa, I. M., Field data for the structural design of coal bunkers,** *Proc. Amer. Soc. civ. Engrs.* **80,** Separ. no 430, 19 pp. Apr. 1954.

986. **Krishna, J., Economic aspects of the design of R. C. retaining walls,** *Civ. Engng. Lond.* **49,** 573, 574; 262–264, 385–386, Mar., Apr. 1954.

987. **Bechert, H., Stress redistribution by creep and shrinkage of the concrete in a simply symmetrical concrete beam, prestressed in a number of layers** (in German), *Ing.-Arch.* **22,** 3, 211–214, 1954.

Starting from Dischinger's equation for plastic strain of concrete, a system of coupled differential equations is derived in explicit matrix form. Solution is obtained by rapidly converging approximate procedure of Picard-Lindelöf.

From author's summary by F. J. Plantema, Holland

988. **Gifford, F. W., The theory and design of axially loaded prestressed concrete tension members,** *Proc. Instn. civ. Engrs.* **2,** part III, 3, 604–608, Dec. 1953.

It is shown that the "exact" solution is unsuitable for deriving the concrete section, but can be used to check a section if obtained by other means. Two simple methods are given for calculating the concrete section required.

From author's summary by C. J. Bernhardt, Norway

989. **Gifford, F. W., The design of simply supported prestressed concrete beams for working loads,** *Proc. Instn. civ. Engrs.* **2,** part III, 3, 589–603, Dec. 1953.

Specifying limiting ranges for the concrete stresses, the stress equations are reduced to two simultaneous equations to be solved for the depth of the section. To assist in selecting proper sections, a general section is broken down into three rectangles approximating to the section, and a table of section properties is given.

From author's summary by C. J. Bernhardt, Norway

990. **Pagano, M., Experimental statistical study of beams of prestressed concrete** (in Italian), *G. Gen. civ.* **91,** 10, 578–588, Oct. 1953.

Results are given of experimental statistical determinations of the tension drop obtained on beams of prestressed concrete in two different cases. The deformations have been measured during the period between the starting of the tension of the cables and the setting of the permanent weights on the beams; then, by means of simplified hypothesis for the deformation-tension relation, two limit results are obtained in which the result of tension drop with time is shown. 20% should be deducted as an approximate figure for this tension drop. L. J. Piatti, Argentina

991. **Selberg, A., Suspension bridges of small and medium span** (in German), *Stahlbau* **23,** 5, 97–102, May 1954.

Article starts with a review of various Norwegian short-span suspension bridges with very flexible stiffening truss and their behavior under mobile loads. It is stated that the vertical acceleration, not the deflection, of the stiffening truss under mobile loads is the quantity which sets the practical upper bound for how flexible a suspension bridge can be made. The author then proceeds to deduce the basic equations for the stiffening truss and arrives at Rode's differential equation, but prefers to base his further deductions on the Melan equation. Influence lines for the bending moment and for the load on the hangers at the middle of the bridge are given. L. N. Persen, Norway

992. **Topaloff, B., Steady wind loads on suspension bridges** (in German), *Stahlbau* **23,** 5, 109–113, May 1954.

Article concerns the problem of finding the bending moments in the stiffening truss due to stationary wind pressure. The creation of oscillation of the bridge due to wind forces is outside the scope of the article, and the problem is a stationary one. The differential equation for the deflection line of the stiffening girder is derived and solved by an approximate method using Fourier series, taking only three terms into account. The author gives the results of five examples for an ordinary suspension bridge over three span, which may or may not be continuous, and five similar examples for a suspension bridge with auxiliary cables of the Dischinger type. [*Bauingenieur* 1949, Heft 3 and 4.] In his summary author states that he intentionally avoided the rigorous solution of the differential equation of the problem to make the method of calculation available to a larger group of the profession, but reviewer thinks that an outline of this rigorous solution would have increased the value of the article. There seems to be a misprint in Eq. (4), and a definition of the independent variable ζ does not seem to be given explicitly.

L. N. Persen, Norway

993. **Stephenson, H. K., and Cloninger, K., Jr., Stress producing effects of equivalent design loads on modern highway bridges,** *Tex. Engng. Exp. Sta. Bull.* 132, viii + 77 pp., Aug. 1953.

The degree of overstress (or understress) that would be produced at some critical point in a given highway bridge can be determined by comparing the total stress (dead load, live load, and impact) resulting from the passage of any particular heavy vehicle with the total design stress used at the same point. This is accomplished by converting a stress function such as moment, shear, or direct stress into an equivalent design load which is then used with any desired allowance for impact to determine the design stress ratio produced by it at some critical point in the bridge. From authors' summary

994. **Dotzauer, H., and Krause, H., Experimental and theoretical investigation of the new girder bridge on the Wesel** (in German), *Bauingenieur* **29,** 10, 385–392, 1954.

995. **Anonymous, The Washo Road Test. Part I: Design, construction, and testing procedures,** *Nat. Res. Counc. Highway Res. Bd. Spec. Rep.* **18,** 121 pp. 1954.

This report is the first of two final reports on the Washo Road Test. It includes a comprehensive description of the project, methods of test operation, and instrumentation procedures. It

also includes a complete report of the construction of the test road, summarizing all data taken in construction control and related operations. The purpose of this report is to provide the basis for a complete and thorough understanding of the test and of the test pavements as they were actually constructed. A second report, to be published in 1955, will give the results of the imposed truck traffic.

The Washo Road Test is a study of the behavior of certain flexible pavements under the repeated application of a number of selected heavy axle loads. For this test, special pavement sections were built in the summer of 1952, and controlled test traffic was begun in November of that year. Traffic was stopped when the subgrade became frozen and was resumed in the spring of 1953 and again discontinued for the winter late in 1953.

From summary

996. Kiselev, V. A., Rationalaxis of a three-hinge arch of underwater tunnels of constant cross section (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **90,** 1, 45–48, 1953.

Exact mathematical solution of problem is given, practical significance of which relates to a case of three-hinged arch of underwater tunnels. For practical use, a numerical example would be desirable. V. Mencl, Czechoslovakia

997. Thüsing, H., Theory of transport chutes, and railway and highway curves (in German), *ZVDI* **96,** 24, 805–813, Aug. 1954.

Author analyzes the forces acting upon a body sliding downward in a curved or spiral transport chute and he develops methods for computing either the motion of transported goods in a chute of given form (spiral chute with circular, elliptical, or parabolical bottom) or the form of a chute for a fixed way of transportation. Nomograms facilitate the numerical evaluation. Applications of results obtained for spiral transport chutes to highway and railway curves are only briefly adduced.

F. Krupka, Czechoslovakia

998. Boeckh, Determination of the elastic constants of airplane tires, *NACA TM* 1378, 39 pp., Nov. 1954. (Translation of Focke-Wulk Flugzeugbau GmbH, Bremen/Werkstoff-Versuchsabteilung, no. 13 3703.)

For determination of the elastic constants of airplane tires which are required for the numerical calculations of the shimmy properties of nose and tail wheels, deformation measurements were carried out on four different tires. For this purpose, the tires were loaded in each case with a normal load and then with a lateral force, a tangential force, and a moment.

Moreover, the weight and the mass moment of inertia about a vertical axis were determined for the various tires.

From author's summary

999. Broadbent, E. G., The rolling power of an elastic swept wing, *Aero. Res. Counc. Lond. Rep. Mem.* no. 2857, 19 pp., July 1950, published 1954.

An iterative method of solution is proposed for the problem of loss in rolling power due to deformation of a swept wing. A specific Mach number is assumed and appropriate aerodynamic derivatives are obtained. The derivatives are defined for an arbitrary mode of deformation of the wing and are assumed constant. A particular value of rolling power is assumed and defined as the ratio between the rolling velocity of the aircraft considered to that of an identical aircraft under the same conditions, but with infinitely stiff wings. It is then necessary to obtain the mode of deformation of the wings to solve the equations in terms of the dynamic pressure. The suggested method expresses the elastic properties of the wing by two square matrixes of flexibilty coefficients, derived from the application of a vertical load and a pure torque about an axis perpendicular to the aircraft centerline, respectively. A matrix iteration process, repeated for each assumed value of rolling power, yields a graph of rolling power versus altitude for the chosen Mach number. The method appears applicable at subsonic and supersonic speeds, and compressibility effects can be included provided the variation with Mach number of the aerodynamic derivative is known.

R. M. Spath, USA

1000. Hitchcock, L. M., Optimum structure for large aircraft, *Aero. Engng. Rev.* **13,** 11, 50–55, Nov. 1954.

Rheology (Plastic, Viscoplastic Flow)

(See also Revs. 962, 987, 1011, 1022, 1023, 1026, 1027)

1001. Mathieu, M., Introduction to rheology (in French), *ONERA Publ.* no. 70, 45 pp., 1954.

This address, on the occasion of the formation of a French "group" in rheology, gives a survey of what by now has become classical rheology [AMR **4,** Rev. 202] including rubber elasticity, but containing nothing new except that reference is made to the paper on a theory of the behavior of solid viscous materials read by Le Boiteux at the congress on theoretical and applied mechanics at Istanbul, 1952 (proceedings of which are about to be published). M. Reiner, Israel

1002. Odqvist, F. K. G., Influence of primary creep on column buckling, *J. appl. Mech.* **21,** 3, p. 295, Sept. 1954.

When an axial compressive force is applied to an initially slightly curved column, its curvature increases with time provided the material is subject to creep. The connection between force, initial deviation from straightness, additional deformation, and time has been known for materials that undergo only linear elastic and nonlinear steady-creep deformations. Paper generalizes earlier results by including instantaneous nonlinear permanent deformations which often satisfactorily represent the effect of primary creep. N. J. Hoff, USA

1003. Hopkins, H. G., and Prager, W., On the dynamics of plastic circular plates, *ZAMP* **5,** 4, 317–330, 1954.

In a previous paper [AMR **7,** Rev. 1752] authors discussed bending of a rigid-plastic plate subjected to a radially symmetric normal load. In particular, they found the unique "collapse load" for which displacements are first possible. Here they discuss the results of a load greater than the collapse load. Such loading produces accelerations and hence inertia forces must be included.

The plate is assumed to be made of a rigid-plastic material which satisfies Tresca's yield condition without strain-hardening, and the associated flow rule. Basic equations are set up for arbitrary loading and boundary conditions. Complete solution is given for a simply supported plate loaded by a uniformly distributed load which has a finite constant value for a certain time interval and otherwise vanishes. P. G. Hodge, Jr., USA

1004. Torre, C., Criticism and extension of Maxwell's law for viscoelastic materials. Torsion of rods as an example (in German), *Öst. Ing.-Arch.* **8,** 1, 55–76, Feb. 1954.

This valuable paper of the well-known Austrian elastician extends the theory of Maxwell's viscoelastic substance in several respects by introducing a volume viscosity or a viscous resistance also for the small volumetric strain, i.e., the volume dilatation in

following certain relations reported in Arnold Sommerfeld's "Treatise on theoretical physics" [vol. II, Mechanics of deformable bodies, Wiesbaden, 1947] and for the purpose of developing a theory of viscoelastic torsional oscillations. Some of the subjects characterizing author's paper are: the time derivative of the stress tensor, the tensors of the rotation, the twist of a solid round bar, the torsion of a bar of rectangular cross sections.

Author assumes that the stress tensor is a function (apart from the time and the space vector) of the rotation associated with the presence of unit shears or shearing stresses in a twisted cylinder or prism. He develops his general, dynamic equations in terms of Gibbsian vector geometry, which cannot be reviewed here. The examples to which he applies these equations refer to the elastico-viscous twist of a hollow cylinder, the oscillations of decaying nature of a solid, round bar and those in a bar of rectangular cross sections. He claims that the cross sections of a slightly twisted round bar are distorted in slightly bulging paraboloids of revolution. Some tests are mentioned which were made by S. Soretz [*Öst. Bauztg.* **4,** p. 85, 1949], corroborating author's theory of torsional oscillations in steel bars predicting a lengthening of a twisted rod. A. Nadai, USA

1005. **Braun, I., The momentum equations of the Renier liquid,** *R. C. Circ. Mat. Palermo* (2) **2,** 3, 258–265, Sept./Dec. 1953.

Author substitutes the constitutive equations of a Renier-Rivlin fluid in Cauchy's equations of motion, specializing the result to physical components in orthogonal coordinates.

C. Truesdell, USA

1006. **Morton, P. H., Treon, R., and Baldwin, W. M., Jr., Low temperature embrittlement mechanics deduced from zinc single crystal fracture studies,** *J. Mech. Phys. Solids* **2,** 3, 177–196, Apr. 1954.

The most important conclusion of this work is that low-temperature brittleness in zinc single crystals is not due to the cessation of slip below a certain temperature. On the contrary, slip is quite active, and it is its activity that induces low-temperature brittleness: slip causes rotation of the lattice which, in turn, sets up orientation gradients adjacent to constricted and unslipped regions. At high temperatures these orientation gradients are accommodated by bend planes; at low temperatures, by cleavage. From authors' summary

Failure, Mechanics of Solid State

(See also Revs. 970, 978, 982, 1022, 1032)

1007. **Kawamoto, M., and Nishioka, K., Safe stress range for deformation due to fatigue,** ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-10, 9 pp.

The safe stress range used in designs for fatigue is defined as those values of mean stresses and stress amplitudes so that no permanent set larger than the yield strain shall result. The upper bound of this range is determined by the fatigue limit and the yield limit of the material. Generally, the latter is taken as the static yield stress. The author presents in this paper some empirical formulas for determining the fatigue yield limit under repeated cyclic stresses. The constants in these empirical formulas are to be determined by endurance tests and by static tests. The fatigue yield limit is found lower than the static yield limit. Experimental data obtained by the author for steel specimens under cyclic torsional and bending stresses are shown in good agreement with the calculated values.

H. Lin, USA

1008. **Cox, H. L., Fatigue,** *J. roy. aero. Soc.* **57,** 513, 559–565, Sept. 1953.

Author clearly presents problems involved in understanding fatigue. He brings out such problems as crack propagation and the statistical nature of fatigue and answers them partially by drawing on his own laboratory studies. C. F. Peck, Jr., USA

1009. **Gadd, E. R., Fatigue from the metallurgist's viewpoint,** *J. roy. aero. Soc.* **57,** 513, 565–580, Sept. 1953.

Author has collected results from 78 different reports and catalogued the information for ready use. He has shown the effect on the fatigue strength of: Structural discontinuities (inclusion in the metal); direction of rolling; surface hardening by nitriding, cyaniding, carburizing, and heat treatment; decarburization; cold work; surface coatings; temperature; and environment. Tables are presented which give the numerical value of the effect of each on various grades of steel.

C. F. Peck, Jr., USA

1010. **Owner, F. M., Fatigue in engine design,** *J. roy. aero. Soc.* **57,** 513, 580–591, Sept. 1953.

A general discussion of design features which must be considered when fatigue is important. The paper is of use to the designer who is considering fatigue for the first time.

C. F. Peck, Jr., USA

1011. **Schweizerhof, S., Magnetic analyses of the residual stresses following plastic deformation and fatigue** (in French), *ONERA NT* no. 17, 52 pp., 1953.

Paper presents a systematic review of the present theories, and derives two relationships between the initial permeability, Rayleigh's coercive force coefficient, and the internal forces between crystals of material. Method is applied to the study of drawn wires and indicates that the crystal forces become very uneven after plastic flow has begun. It is noted that the effect on the magnetic permeability is strongly time-dependent. Under repeated loads, the permeability rapidly tends toward a constant value, the rate of approach being greater if large residual stresses are present. Bibliography has 54 entries.

T. A. Hunter, USA

1012. **Eyers, J., Inspection, explosion and breakdown of boilers and pressure vessels,** *Instn. mech. Engrs.*, 16 pp., Nov. 1954.

1013. **Bowden, F. P., and Williamson, J. B. P., The influence of electrical current on the contact between metals,** *Research Corresp., Suppl. to Research* **7,** 10, S53–S54, Oct. 1954.

Material Test Techniques

(See also Revs. 950, 998, 1024, 1213)

1014. **Grodzinski, P., Micro-indentation hardness: its elastic, plastic and fracture components,** *Metallurgia Manchr.* **50,** 299, 125–131, Sept. 1954.

Author suggests that effect of load on microhardness is due to noticeable influence of elastic deformation. In analogy to Meyer's law for ball hardness, power law is assumed for microplastic hardness with sharp indenters.

The constant is taken as hardness measure. Elastic part of deformation was determined by comparing deformation with double-cone indenter on surface coated with thin silver or soot film (total deformation) and clean surface (plastic deformation).

Contrary to plastic deformation hardness, total deformation hardness decreases with decreasing load. Author also developed instrument for depth determination during loading and after removal of load, allowing exact measurement of plastic and elastic part of deformation. Finally, it is shown that the double-cone indenter causes least fracturing on brittle materials.

J. H. Palm, Holland

1015. Dugdale, D. S., Cone indentation experiments, *J. Mech. Phys. Solids* **2,** 4, 265–277, June 1954.

Indentations were made in three cold-worked metals, namely, mild steel, copper, and aluminum, using indenting tools of cone angles between 10° and 140°. The indenting tools were lubricated to reduce the coefficient of friction to a low value. Minimum permissible sizes of indentation specimens were determined. The shear yield stress of the materials was found from torsion tests. Precautions were taken that nonuniformity and anisotropy should not vitiate the results. The ratio between mean indentation pressure and shear yield stress was found to be approximately the same for the three materials, and the variation of indentation pressure with cone angle is shown. Measurements of the volume of the raised lip and shape of the impression are given. The possible influence of plastic-elastic effects on the observed indentation pressures is discussed. From author's summary

1016. Preusser, H. M., O'Connell, R. A., Yeiser, A. S., and Lundgren, H. P., Single fiber stress-strain apparatus, *Textile Res. J.* **24,** 2, 118–122, Feb. 1954.

1017. Rubinsky, I. A., and Rubinsky, A., A preliminary investigation of the use of fibre-glass for prestressed concrete, *Mag. Concr. Res.* **6,** 17, 71–78, Sept. 1954.

This paper discusses the feasibility of using fiber-glass reinforcement for prestressed concrete, summarizing the physical properties of fiber glass and some experimental work carried on by the authors. It also gives practical suggestions for future research and concludes with a comparison between fiber-glass and conventional steel reinforcement. From authors' summary

1018. Hartman, A., A comparative investigation on the influence of sheet thickness, type of rivet, and number of rivet rows on the fatigue strength at fluctuating tension of riveted single lap joints of 24S-T-alclad sheet and 17S rivets, *Nat. LuchtLab. Amsterdam Rap.* M.1943, 8 pp., Feb. 1954.

Fatigue tests at fluctuating tension were carried out on riveted single lap joints of 24S-T alclad sheet and 17S rivets to determine the influence of sheet thickness, type of rivet, and number of rivet rows. The results indicate that, for the type of specimen used, a change of sheet thickness has no influence on the fatigue limit (calculated as stress range in the sheet, $n = 50.10^6$), but that except for NACA rivets, at high loads thicknesses exceeding 1 mm give a decrease in endurance at the same stress amplitude. The type of rivet (snap rivet, countersunk V rivet, countersunk NACA rivet) too has no influence on the fatigue limit, but the NACA rivet is superior to the two other types of rivets at relatively high loads. Increase of the number of rivet rows from 2 to 3 at the same static strength of the joint has no influence on the *S-N* curve of joints with 0.8-mm and 1.2-mm sheets.

From author's summary

1019. LaTour, H., and Sutton, R. S., Improved scale system for stiffness testing machine, *ASTM Bull.* no. 196, 50–53, Feb. 1954.

Bend or stiffness tests requiring simultaneous readings of load and angle may be made more accurately and with less operator fatigue by mounting a rotatable inverse angle scale directly below the fixed load scale of machines of the Tour-Marshall design. A method of adapting this principle to Tinius Olsen stiffness testers of 6 and 60 in.-lb capacities is illustrated and described.

From authors' summary

1020. Alden, J., Life assessment tests for commercial vehicles, *Instn. mech. Engrs. Proc. Auto. Div.*, part II, 72–79, 1952–1953.

Mechanical Properties of Specific Materials

(See also Revs. 969, 1016, 1017, 1173)

1021. Horger, O. J., edited by, Metals engineering design—ASME Handbook, New York, Toronto, London, McGraw-Hill Book Co., Inc., 1953, xv + 405 pp. $10.

This particular volume is one in the presently planned series of ASME Handbooks. It is divided into six sections dealing with selection of material, mechanical properties of metals in design, mechanical factors influencing corrosion, metallurgical factors in design, processing considerations in design, and design procedures. Many authorities have contributed articles to each section and the result gives a very concise treatment of each subject. Pertinent bibliographies at the end of each section add to the usefulness of the volume.

Section 2, dealing with the mechanical properties of metals, to which well-known authorities have contributed, is particularly good and covers the subject of fatigue in an excellent manner. Such controlling factors as mean stress, form and surface effects, surface-strengthening processes are fully covered. The title of section 4, "Metallurgical factors in design," may be confusing since the subject matter of this section deals exclusively with nondestructive testing. Part 5, on processing considerations, does not appear to be adequately covered by two short articles dealing with surface finish criteria. No mention is made of welding or casting processes, and more could have been said without encroaching on the other volume in the series which will be devoted to processes.

In general, the subject matter of each article is good and covers each topic in a comprehensive manner, but the titling of each part is not good and possibly should be modified in future editions.

J. M. Lessells, USA

1022. Harris, G. T., and Child, H. C., A statistical study of the creep and fatigue properties of a precision-cast high-temperature alloy, *J. Iron Steel Inst. Lond.* **178,** part 3, 284–290, Nov. 1954.

The average mechanical properties at room temperature, the creep strength at 700–850 C, and the fatigue strength at 700–870 C have been evaluated for precision-cast G.34, a cobalt-base alloy developed for gas-turbine rotor blades. A quality control study of the rupture strength of G.34 castings has shown that the precision-casting process can be used to give consistent properties in that no greater scatter in properties need be expected from heat to heat than within one heat.

The scatter of the 300-hr rupture strength and the endurance strength (40×10^6 reversals) at 750 C has been shown to be $\pm 10\%$ and $\pm 22\%$ ($\pm 2\sigma$). The practical implication of these results is that the average values of the high-temperature properties must be reduced by about 15% in the case of applications where creep is the limiting factor and by about 30% where fatigue is of major importance.

For an alloy of this type, fatigue is probably of major impor-

tance at temperatures up to about 800 C, while creep is more important above this range. Accordingly, best use can be made of this cast material above 800 C, and it is above this temperature that the properties become attractive in comparison with existing wrought materials. At these higher temperatures the scatter in properties is also smaller. From authors' summary

1023. **Olds, G. C. E., Mechanisms of creep in a precipitation hardened alloy,** *Proc. phys. Soc. Lond.* (*B*) **67,** part 11, 419B, 832–842, Nov. 1954.

The binary alloy 97% copper–3% silver was selected as the most ideal alloy for research on the creep process in a precipitation-hardened alloy. A heat treatment was devised which gave a slightly overaged Widmanstätten structure of high internal hardness and maximum stability. Wires of the alloy were subjected to deformation over a range of constant stresses at temperatures from 100 C to 300 C. Two mechanisms of transient creep were observed and were found to be complementary. The first mechanism occurred at the lower temperatures, giving creep strain proportional to ln (*time*), while the second mechanism, in which creep was proportional to $(time)^{1/3}$, appeared and became dominant at higher temperatures. A quasi-viscous creep mechanism was also observed, which at high temperatures was more important than the transient process. The linear nature of the quasi-viscous creep was limited by a critical time and was believed to be governed by the plastic deformation which occurred on loading. The three mechanisms observed agree with some theoretical analyses which have been put forward.

From author's summary

1024. **Weisberg, H., and Soldan, H. M., Cyclic heating test of main steam piping materials and welds at the Sewaren Generating Station,** *Trans. ASME* **76,** 7, 1085–1089, Oct. 1954.

1025. **Sidebottom, O. M., and Clark, M. E., The effect of size on the load-carrying capacity of steel beams subjected to dead loads,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-12, 9 pp.

When mild-steel members are subjected to dead loads, catastrophic yielding occurs in the member at a stress level less than the conventional yield point, thus lowering the load-carrying capacity of the member below the expected value. The present investigation was undertaken to determine if this type of action was dependent on the size of specimen. A total of 18 geometrically similar rectangular mild-steel beams having depth of 3, 1, $\frac{1}{2}$, and $\frac{1}{4}$ in. were subjected to dead loads. The experimental hinge moment for the three largest sizes was independent of beam depth and the average value was found to be 9.3% below the theoretical fully plastic moment; the average hinge moment for the $\frac{1}{4}$-in. beams was 1.3% above the theoretical. The increased load-carrying capacity is believed to be associated with the steeper stress gradient, which appears to alter the spread pattern of yielding in the shallow beams. A study also was made of the behavior under dead loading of beams made of a high-strength, low-alloy steel (Mayara R). Like mild steel, this material exhibits a definite yield point; therefore, the behavior of these beams when subjected to dead loads was also similar to that observed for mild-steel beams. The average experimental hinge moment was 10.7% below the theoretical value.

From authors' summary

1026. **Elsesser, T. M., and Corten, H. T., The influence of repeated loads on the residual stresses in inelastically deformed beams,** ASME Fall Meet., Milwaukee, Wis., Sept. 1954. Pap. 54—F-13, 12 pp.

The importance attributed to the initial residual stresses in a machine member presumes that the residual stresses remain unchanged throughout the service life. However, the occurrence of inelastic deformation accompanying repeated loading will alter the residual-stress distribution. This investigation was undertaken to determine the changes resulting from repeated cycles of overload in the residual stresses induced during the initial overload in beams loaded from zero to a maximum. Tests were conducted on beams of rectangular cross section made from medium-carbon (SAE 1035 and SAE 1045) and alloy (SAE 4340) steels. Two methods were employed to measure the residual stresses. Both methods indicated an increase in the residual stresses in the outermost fibers of the beams with increasing numbers of load repetitions. It was found that additional inelastic deformation occurred during load cycles after the first, particularly in the medium-carbon-steel beams. From authors' summary

1027. **McEvily, A. J., Jr., and Hughes, P. J., An experimental and theoretical investigation of the anisotropy of 3S aluminum-alloy sheet in the plastic range,** *NACA TN* 3248, 45 pp., Oct. 1954.

The results of tension and compression tests on 3S aluminum-alloy sheet are presented together with values of Poisson's ratio in the plastic range. Crystallographic anisotropy was found to be responsible for the variation in Poisson's ratio in the width and thickness directions of specimens aligned at various directions with respect to the rolling direction in the plane of the sheet. X-ray diffraction studies of annealed specimens were made and pole figures showing the type of preferred orientation were drawn. A theoretical analysis was made to account for the observed anisotropy based on the behavior of single crystals and the texture of the sheet. An independent check of the theory is afforded through comparison with experimental data on cubically aligned copper sheet. From authors' summary

1028. **Taylor, J. R., and Adams, C. H., Weather aging of styrene and phenolic plastics,** ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-68, 9 pp.

1029. **Painter, G. W., Dynamic characteristics of silicone rubber,** *Trans. ASME* **76,** 7, 1131–1135, Oct. 1954.

The unusual high- and low-temperature properties of silicone rubber have made it a desirable material for vibration isolators designed for service at temperature extremes. In general, silicone cannot be substituted directly for such elastomers as natural rubber and neoprene in established designs. This lack of interchangeability results principally from the lower tensile strength and the usual load-deflection characteristics of the material. A program to investigate the dynamic properties of silicone rubber was undertaken to provide the design engineer with information which would allow the material to be utilized properly. This paper deals with the viscoelastic properties of silicone rubber under various conditions of strain frequency, and temperature. Where possible, comparisons are made with natural rubber.

From author's summary

Mechanics of Forming and Cutting

(See also Revs. 908, 928, 1211)

1030. **Cledwyn-Davies, D. N., The effect of grinding on the fatigue strength of steels,** *Instn. mech. Engrs.*, 3–11, 1954.

Author's two major conclusions—(1) the grinding of steels under good grinding conditions has no deleterious effect on the fatigue strength of the steel, and (2) poor grinding technique causes a reduction in the fatigue strength of steels—are weakened by a

lack of definitive description of "good" and "poor" grinding conditions. Further, the use of the same wheels, feeds, and speeds on all the test steels, which varied in BHN from 141 to 286, would seem to this reviewer to result in highly arbitrary and uncontrolled test conditions. Statement regarding coolant is regarded similarly: "Throughout the grinding, a copious flow of coolant was used, and no special cleaning apparatus was used for the coolant, although had such precautions been taken, it would have been possible to obtain even finer finishes." Because of the above items, plus the small number of specimens and large scatter of data points, the numerical results do not appear significant. Results were presented as a plot of a ratio: maximum fiber stress to nominal ultimate stress vs. log N; this ratio being introduced to avoid the effect of the experimentally determined large variation of ultimate stress along and across the bar. It would appear more desirable to have eliminated this variation (with its concomitant variation in structure and thus reaction to grinding) than to introduce a relatively unfamiliar parameter which tends to obscure an inherent condition affecting the test results.

Reviewer agrees with a concluding general remark: "Grinding is an important production operation, and there is need for more work to be carried out upon its effects on the properties of steels. . ." C. C. Osgood, USA

1031. Opitz, H., and Fröhlich, K. H., Recent research on tool wear when face milling steel with carbide (in German), *ZVDI* **96**, 25, 822–830, Sept. 1954.

Types of tool wear and their significance for tool life are described and discussed in detail.

Wear on top (cratering) is expressed by the parameter (*depth of crater/distance from edge*). Checks caused by alternating thermal load are explained. Indication by oscillograph is used for determining cutting speeds corresponding to beginning of type 2 chips (continuous). A dexterous and fast method has been developed for measuring tool wear with cutter mounted on spindle: a profilometer records the crater horizontally in magnification 10× and vertically 100×, and a camera coupled to a microscope records the wear on relief in magnification 5×. In addition to instruments for measuring cutting forces and tool temperatures, a small-size device has been developed for measuring vibrations during machining.

Finally, a criterion of tool wear in relation to tool life is given for materials comparable to AISI C1037, C1050, and a low-Cr-Mn alloyed steel. Tool wears (crater, relief) are plotted on tool-life vs. cutting-speed chart. R. R. Hanson, Sweden

1032. Bass, L., On the theory of grind milling (in German), *ZAMP* **5**, 4, 283–292, 1954.

A mathematical theory of grind milling is developed by deriving and solving a partial integral-differential equation which gives the relationship between the statistical particle-size distribution in the milling charge and milling time. The equation contains a characteristic function of both the mill and the material milled. This function is based on experiments conducted in accordance with an approximation derived for this purpose from the general theory.

Several approximate solutions of the equation as well as the exact solution are worked out, and an analysis of the semi-empirical Rosin-Rammler formula is given from the point of view of the presented theory.

From author's summary by D. Kececioglu, USA

1033. Hartwig, C. H., Sixty-cycle induction heating of large steel sections for rolling, ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-77, 31 pp.

Hydraulics; Cavitation; Transport

(See also Revs. 904, 921, 996, 1135, 1136, 1219)

1034. Kaufmann, W., Technical hydro- and aeromechanics [Technische Hydro- und Aeromechanik], Berlin, Springer-Verlag, 1954, viii + 352 pp., 254 figs. DM 36.

This textbook, as the name implies, concerns two very important fields of engineering. The author has seen fit to cover both introductory and basic subject matter under one cover, which is commendable in one sense, while in another it is open to argumentative criticism. Reviewer feels that there is sufficient importance and ample scope in subject matter to treat the two topics separately—granting, of course, that many of the basic principles and theories are similar or identical. It is further believed that such an arrangement will tend to place the book in the reference category.

The first section of the book is concerned with the fundamental principles of hydro- and aerostatics; such specific items as pressure effects on vessels and submersed objects, buoyancy, and the normal atmosphere are considered. The next portion takes into account the dynamics of fluids, discussing such basic equations as the equation of continuity, Bernoulli's equation, and Toricelli's theorem. Particular applications of the venturi tube, the orifice, the pitot-static tube, and flow out of a container are given. The remaining part of this section discusses viscous-fluid theory and Reynolds numbers effects in pipes. The scope is quite adequate, as is the presentation.

The next section deals with perfect-fluid and viscid-fluid theory from the classical hydrodynamic point of view. Some higher mathematics are essential in this section, since the discussion centers around Euler's equations of motion, the Navier Stokes equations, potential theory, the circulation theory of lift and the Joukowski transformation.

The remainder of the text is devoted to gas dynamics, dealing with such topics as one-dimensional flow, Mach number effects, linearized potential theory, the effects of sweepback, supersonic flow around a corner, i.e., the Prandtl-Meyer expansion, and supersonic flow from a nozzle.

This book contains some extremely useful information, particularly in the parts devoted to the viscous-flow theory, Prandtl's lifting-line theory, propellers, and the gas-dynamics section. Apart from the criticism taken earlier, reviewer recommends the book quite highly, especially as a reference text in one's own library. G. B. White, USA

1035. Federhofer, K., Problems in hydromechanics [Aufgaben aus der Hydromechanik], Wien, Springer-Verlag, 1954, v + 221 pp., 235 figs. $5.70.

The author has added a new collection of problems in statics and dynamics of incompressible fluids to his three volumes on problems in mechanics of solids. Thus he continues the valuable work of his predecessor, Prof. Wittenbauer (1911–1917). Carefully composed and perfectly edited, book contains 245 problems, mostly authentic, with detailed solutions and explications. Chapters cover pressure in liquid, surface forms, pressure on plain and curved surfaces, lift and floating, outflow from containers, laminar flow, flow in pipelines and in open channels, oscillations, impulse-momentum principle, elements of mathematical hydrodynamics, ground-water flow, model similarity laws. All data are in metric units; several new terms and units are introduced, as N (Newton) for power, kp (kilopond), earlier called kp-weight, Torr (Torricelli) for 1-mm Hg column. Book is of particular importance in Europe, where textbooks do not include problems.

S. Kolupaila, USA

1036. **Supino, G., Hydraulic lessons [Lezioni di idraulica],** Bologna, Casa Editrice R. Pàtron, 1954, 320 pp., 148 figs. Lire 3000.

The work is intended to serve mainly students of engineering. It presents a complete exposition of the whole matter with special consideration of the recent advances in the hydraulic field. For instance, it includes for the determination of the flow coefficient $\lambda = \lambda(R, \epsilon/d)$ the Colebrook equation, as well as both very practical formulas of the author which are developed out of the Colebrook formula. Besides, there is also a table with the coefficients of roughness ϵ compiled by E. Marchi.

P. Franke, Germany

1037. **Mologin, M. A., Forms of flow of gas-liquid mixtures in horizontal tubes** (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **94**, 5, 807–810, 1 plate, Feb. 1954.

The flow of air-water mixtures was investigated in tubes of different diameter. This investigation provided curves showing the ranges of seven forms of flow specifically defined by the author, and shows that the ratio of mixture velocity to tube diameter is a function of gas content in the mixture.

The paper is a progress report in a continuing investigation of two-phase two-component flow. W. B. Palijenko, Canada

1038. **Haberman, W. L., and Morton, R. K., An experimental investigation of the drag and shape of air bubbles rising in various liquids,** *David W. Taylor Mod. Basin Rep.* 802, 55 pp., Sept. 1953.

The data are presented in terms of the usual dimensionless parameters C_D, R, and W, and a new one, $M = g\mu^4/\rho\sigma^3$, which was introduced by another author, Rosenberg [AMR **4**, Rev. 2568].

For Reynolds numbers below 0.25 the bubbles are all spherical, and their drag coefficients fall between Stokes' curve for solid spheres and the Hadamard-Rybczynski curve for fluid spheres (C_D about $^2/_3$ that of Stokes). With increasing Reynolds (and Weber) numbers, the bubble shapes change to oblate spheroids and then to spherical caps. The transition points vary from liquid to liquid. Spherical caps occur in all liquids tested for $R > 4500$ ($W > 20$), and their drag coefficient is constant, $C_D = 2.6$ approximately. In the intermediate (oblate spheroid) zone, the drag-coefficient curve goes through a pronounced minimum for liquids of low M, and no minimum for high M.

Reviewer believes that data presented so far do not justify retention of M as a significant parameter. Transitions in bubble shape do not correlate with M, while the behavior in the intermediate zone can be correlated with the viscosity above just as well as with M.

The test results are a valuable contribution in an area that is of interest for various applications. An extensive list of references is included in the report, and an abbreviated list in the ASCE paper. J. Levy, USA

1039. **Haberman, W. L., and Morton, R. K., An experimental study of bubbles moving in liquids,** *Proc. Amer. Soc. civ. Engrs.* **80**, Separ. no. 387, 25 pp., Jan. 1954.

See preceding review.

1040. **Benfratello, G., Motion of an air bubble through a fluid at rest** (in Italian), *Energia elett.* **30**, 2, 80–97, Feb. 1953.

First part of a series of studies of the bibliography on bubble motion existing in early 1953 is presented. Author begins with the researches on the formation of a single bubble through a nozzle submerged in a liquid. Then, conditions for the starting of motion are discussed and the movements are classified into four classes: (a) Bubbles with less than 6-mm radius have straight paths; (b) for radius between 0.6 and 1.5 mm (in water), the form of bubbles is still more or less spherical but the paths are ellipsoidal; (c) for radius up to 2.5 mm, the form of bubbles is elliptical, with the minor axis parallel to the mean motion, which is still an ellipsoidal one; (d) when radii increase, the forms are flatter, especially at the lower portion of the bubbles. Author studies the physical behavior of the "shell" which limits the air portion and the liquid, and the volume and weight variations during the motion.

Theoretical studies on motion of bubbles in an infinite fluid are presented, starting with Stokes' formula, which has been found quite applicable to the smallest bubbles. The Oseen formula, which was derived considering the inertia terms in the equation of motion, is discussed and compared to Stokes' formula. Then, author analyzes Basset's formula, derived considering the sliding between the bubble and the liquid. Hadamard's formula is discussed and compared to the previous ones, and the same for Boussinesq and Levic formulas.

The paper ends with a list of 45 references. Reviewer thinks that the main purpose of author, i.e., to furnish a review of existing studies on the subject, is well achieved and that, although not completely original, must be welcome as a help to people connected with these researches. A. Balloffet, Argentina

1041. **Woods, L. C., Unsteady cavitating flow past curved obstacles,** *Aero. Res. Counc. Lond. curr. Pap.* no. 149, 9 pp., Mar. 1953 published 1954.

This paper presents an important contribution to the rapidly growing literature on the theory of free-boundary flows. The problem is of practical interest in aiding the understanding of cavitation phenomena. Unfortunately, few of the mathematical models that have been investigated thus far give satisfactory representations of physically realized cavities. In an effort to remedy some of the deficiencies of other models, Riabouchinsky introduced a second body at which the cavity trailing from the primary obstacle was assumed to be closed. The present paper extends the study of this model for two-dimensional flows to the unsteady case, i.e., the case of a varying length of the cavity.

The problem is treated on a very general basis. Using a series of conformal transformations, it is related to a previously solved problem, and a convenient formulation is obtained which applies whether the second body is present or not and to steady as well as unsteady problems. Thus some previous results of Gilbarg and von Kármán for single polygonal obstacles are immediately derived. An integral equation is derived for the particular case where the cavity trailing from an arbitrary curved obstacle is closed on a simple flat plate. Although this integral equation is rather complicated and a general solution is not available, it lends itself to solution by a method of successive approximations suggested by the author.

It seems to reviewer that even if the author's optimism in regard to the convergence of successive approximations proves to be justified, a considerable amount of labor would be required for the computation of any substantial portion of the time history of an unsteady cavity, inasmuch as the equation would have to be solved for each instantaneous state of motion that is of interest. Also, if such a calculation were attempted, additional information or assumptions in regard to boundary conditions would be required in order to guide the selection of the appropriate rate of change of the length of the cavity. Final judgment in regard to the usefulness of this model of the unsteady cavitation flow will have to await comparison of computations and empirical observations.

A few typographical errors are noted; e.g., in Eq. (4), ρ should

be replaced by $2/U^2$; and, at the top of page 3, Q should be replaced by φ. L. Pode, USA

1042. Truesdell, C., The hydraulic pendulum (in French), "Mémoires sur la mécanique des fluides," *Publ. sci. tech. Min. Air, Paris*, 383–396, 1954.

The paper is concerned with the conditions under which cavitation can occur in an incompressible-fluid column moving under the influence of a conservative force field inside some generally shaped tube of constant cross-sectional area. First, the classical work of Newton, Bernoulli, and Euler is mentioned. The author points out that Euler first discovered that the pressure in the fluid can be determined without knowledge of the motion (since the acceleration is given by the difference of potential energy of the end points). Euler's basic equation for the pressure distribution is then applied to the fluid column in a tube with discontinuous slope and in a circular tube. Theorems for occurrence of cavitation are derived. P. F. Maeder, USA

1043. Voĭnich, T. G., Integrating a differential equation for gradually varied water flow in open channels (in Russian), *Gidrotekh. Stroit.* **22**, 3, 39–41, Mar. 1953.

Differential equation for nonuniform flow applied to a particular reach of an open channel; average values of geometric elements for the end sections are introduced. Integration results in a comparatively simple form

$$l = 1/s_0[h_2 - h_1 - 1.15\,(a - b)\log[(K_1 - 1)/(K_1 + 1)]\cdot[(K_2 + 1)/(K_2 - 1)]]$$

where l is length of a reach, s_0 surface slope for uniform flow, h_1 and h_2 average depth in two sections, $K_1 = (s_c/s_1)^{1/3}$, $K_2 = (s_0/s_2)^{1/3}$, $Z_1 = 1/K_1$, $Z_2 = 1/K_2$, $x_1 = \alpha v_1^2/2g$, $x_2 = \alpha v_2^2/2g$, $a = (h_2 - h_1)/(K_2 - K_1)$, $b = (x_2 - x_1)/(Z_2 - Z_1)$. Trying a surface elevation at the end of a reach, all values can be derived and distance l computed; computation may be repeated several times until results will be close. No tables are necessary. Same method is extended to special problems: (1) Nonprismatic channel with constant depth; (2) horizontal bottom; (3) opposite slope of the channel. Results of computations, as compared with several other methods, show good agreement. Reviewer believes, however, that this computation is more intricate than following the Bakhmeteff method. S. Kolupaila, USA

1044. Gerber, S., Stability condition of a surge tank connected to a pressure gallery which is at the downstream end of a long head-race canal (in French), *C. R. Acad. Sci. Paris* **239**, 5, 391–393, Aug. 1954.

The problem of a surge tank with pressure gallery fed from a long head-race canal has been dealt with by Cuénod and Gardel [AMR 5, Rev. 3322]. In a former paper [title source, **238**, p. 2490, 1954], Gerber dealt with the basic equations ruling this type of hydrodynamic flow. In this paper, he deals with the problem of the stability of the surges in the surge tank and finds that the head-race canal, on the whole, slightly increases the stability. C. Jaeger, England

1045. Geza Bata, M., Stability of two surge tanks in the case of a connection between the head-race pressure galleries (in French), *C. R. Acad. Sci. Paris* **239**, 6, 476–478, Aug. 1954.

Author considers two hydraulic systems with independent pressure tunnels, surge tanks, and pipelines, which are working in parallel. The two independent reservoirs are at the same level. The two systems are interconnected by a transverse pressure tunnel just upstream of the two tanks. The head is the same for both systems. The conditions for surge stability in this complex hydraulic system are analyzed.

Three dynamic equations and two continuity equations (including two conditions for steady turbine output) can be set up. These five differential equations can be linearized. They yield an equation of the fifth order with associated characteristic equation of the fifth degree, to which the stability condition of Hurwitz can be applied. This method has been used for the analysis of the power station of Tablanica, where the transverse tunnel junction increases the stability by 5 to 10%.

C. Jaeger, England

1046. Fedorov, E. P., Surge occurrence in chutes (in Russian). *Gidrotekh. Stroit.* **23**, 3, 29–32, Mar. 1954.

Author checked criteria by Boussinesq and Vedernikov on 22 chutes of different length and slope and found both inadequate to predict the size and location of the produced jump.

S. Kolupaila, USA

1047. Ishihara, T., and Ida, T., Supplementary formulas for rectangular weirs without end-contractions, *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., May 1952, 381–384.

The Rehbock equation for suppressed weirs is limited to weirs under one foot in height. For higher weirs, authors obtained supplementary term to add to coefficient by investigating Shoder and Turner's 1929 experimental data. Altered coefficient was compared to Rehbock's in test on large Japanese weir, and proved superior. Suggested equation for coefficient is: $C = 0.605 + (1/1000h + 0.08h/D)[1 + 0.55(D - 1)]$ where h is the head and D the height, both in meters. D. G. Huber, Canada

1048. Pikalov, F. I., Broad-crested weir of curvilinear profile (in Russian), *Gidrotekh. i Melior.* no. 3, 56–62, Mar. 1954.

Reasonable form of the spillway is proposed and method of its design is suggested. S. Kolupaila, USA

Incompressible Flow: Laminar; Viscous

(See also Revs. 904, 1034, 1035, 1037, 1038, 1039, 1040, 1041, 1042, 1074, 1076, 1094, 1098, 1104, 1113, 1132, 1134, 1135, 1136, 1144, 1174, 1209)

1049. Finn, R., On the flow of a perfect fluid through a polygonal nozzle. I, II, *Proc. nat. Acad. Sci. Wash.* **40**, 10, 983–987, Oct. 1954.

Two short notes are presented, together with the necessary theorems in conformal mapping, on the flow of a perfect fluid through a polygonal nozzle. The first note treats the case of a convex nozzle with restricted curvature. The second note treats the two-dimensional, symmetric, convex polygonal nozzle. Author states that a detailed exposition is in preparation.

T. P. Torda, USA

1050. Di Prima, R. C., A note on the asymptotic solutions of the equation of hydrodynamic stability, *J. Math. Phys.* **33**, 3, 249–257, Oct. 1954.

Author examines error in using the asymptotic inviscid solutions of the Orr-Sommerfeld equation near the singular point $w = c$ by comparing it to an improved solution valid in that neighborhood. Author indicates that Tollmien's estimate of the error can probably be justified rigorously.

J. R. Sellars, USA

1051. Roshko, A., A new hodograph for free-streamline theory, *NACA TN* 3168, 39 pp., July 1954.

In the method of Helmholtz-Kirchhoff for separated flow past a flat plate normal to the stream, the separation velocity and the "base pressure" are fixed at the free-stream values. In the present treatment a modification is introduced to allow arbitrary separation velocity and base pressure, so that values more in conformity with experiment may be chosen. The solution depends then on the single (base-pressure) parameter k. When k is suitably chosen, the drag and the details of the potential flow near the plate agree well with experiment. The computations depend on a particular choice of free-streamline hodograph, which has the feature that it gives a definite wake width for every value of k. In this way the wake width is correlated with the drag.

The same ideas are applied to work out the free-streamline flows for a circular cylinder and a wedge of 90° vertex angle.

From author's summary by J. S. Isenberg, USA

1052. Roshko, A., On the drag and shedding frequency of two-dimensional bluff bodies, *NACA TN* 3169, 29 pp., July 1954.

A short review of the theory of flow past bluff bodies is presented and some experiments are described which demonstrate how critically the whole problem depends on that part of the wake immediately behind the cylinder.

Dimensional analysis of a simple model of that region leads to a universal Strouhal number S*, which is then experimentally determined as a function of wake Reynolds number R*. This result, together with the free-streamline theory of *TN* 3168 (see preceding review) allows the drag to be calculated from a measurement of the shedding frequency and furnishes a useful correlation between different bluff cylinders. Author shows how to combine the free-streamline theory with von Kármán's theory of the vortex street to obtain a solution dependent on only one experimental measurement.

From author's summary by J. S. Isenberg, USA

1053. Schlichting, H., and Truckenbrodt, E., The flow on a rotating body of revolution in axial flow, *J. aero Sci.* **21,** 6, 417–418, June 1954.

The flow in the boundary layer of a rotating body of revolution including the rotating disk in an axial main flow has been calculated by the authors, both for laminar and turbulent incompressible flow, in several German publications. A summary of the results is given. From authors' summary

1054. Eliasen, E., Numerical solutions of the perturbation equation for linear flow, *Tellus* **6,** 2, 183–191, May 1954.

Author considers the equation of small perturbations from a plane steady rectilinear flow. The amplitude of the perturbation potential, assumed exponential in $x - ct$, must satisfy an ordinary linear differential equation of second order. The resulting proper-value problem the author treats by finite differences, thus determining stability and instability in certain cases.

C. Truesdell, USA

1055. Herivel, J. W., A general variational principle for dissipative systems, *Proc. roy. Irish Acad.* (*A*) **56,** 4, 37–44, 1954.

The author sets up extremal principles formally equivalent to the governing equations for discrete mechanical or electrical systems and for compressible viscous fluids. In all these, the accelerations are kept constant while the velocities are varied.

C. Truesdell, USA

1056. Busemann, A., Minimum virtual mass, "Mémoires sur la mécanique des fluides," *Publ. sci. tech. Min. Air, Paris,* 25–40, 1954.

Author presents the results of a philomathic study of the skin shapes which are required to cover prescribed two-dimensional skeleton structures and which result in bodies having minimum virtual mass. It is shown that "the minimum shapes for given ribs and given maximum chord length have all the positive pressures on their flat noses and tails and all the negative pressures around the outer portions of the ribs, while the free surfaces between them have zero pressure above the undisturbed one." Typical solutions and hodographs are presented for bodies with I-beam, diamond beam, box shape, X-beam, H-beam, and flat plate ribs; for bodies in which the body volume is also prescribed; and for one body for which a cavitation limit is given. Although the solutions are not of practical significance because of the infinite velocities in the neighborhood of the ribs, the paper provides a challenging and instructive example of the use and application of the hodograph. J. P. Craven, USA

1057. Collatz, L., and Görtler, H., Tube flow with weak swirl (in German), *ZAMP* **5,** 2, 95–110, 1954.

Authors study laminar swirling pipe flow of a viscous, incompressible fluid. The equations of motion are linearized subject to the assumption that, sufficiently far downstream from an initial section at which the radial swirl distribution is prescribed, the swirl velocity, the radial velocity, and the axial deviation from Poiseuille flow will be small compared with the main stream velocity. The search for the swirl velocity leads to an eigenvalue problem. Properties of the eigenvalues are proved by considering a related integral equation. Lower and upper bounds are found and the first five eigenvalues and eigenfunctions are determined. These are used to discuss the decay of the swirl if a straight line radial distribution is stipulated at an initial section.

Authors are apparently not aware of a similar treatment of the same problem by L. Talbot [AMR **7,** Rev. 2900].

G. W. Morgan, USA

1058. Isay, W.-H., Contribution to the theory of potential flow through radial cascades of blades (in German), *Ing.-Arch.* **22,** 3, 203–210, 1954.

By means of vortex distributions along the boundaries, problem of motion of an incompressible potential flow past a given two-dimensional radial cascade of blades is reduced to an integral equation.

Equations are given for (a) single cascade of infinitely thin airfoils, (b) single cascade of thick airfoils, (c) two cascades of thin or thick airfoils. Solutions are merely formal; no discussion or numerical example is developed. In case (c), reviewer notes that relative motion produces a free vortex distribution (as in case of oscillating profile) which author does not mention.

G. Moretti, Argentina

1059. Nickel, K., On special systems of cascades of lifting surfaces. I (Lifting-line theory) (in German), *Ing.-Arch.* **22,** 2, 108–120, 1954.

An infinite cascade of equal lifting surfaces of finite span is considered according to the Prandtl approximation; the lifting vortexes are parallel, their midpoints are equally spaced in a direction perpendicular to wind stream but oblique to lifting lines. General equations for downwash w along the lifting lines, in terms of their circulation Γ are given; a finite expression for particular distributions of Γ is found. The calculation of Γ for given w leads to an extremely complex integral equation in the general case of a

staggered cascade. For the particular cases of zero stagger and of in-line wings with uniform downwash the complete solution is given. For the lattice of n equal parallel cascades, general expression for calculation of w in terms of Γ, and vice versa, are given.
P. Cicala, Italy

Compressible Flow, Gas Dynamics

(See also Revs. 904, 1082, 1084, 1085, 1089, 1094, 1095, 1096, 1097, 1099, 1100, 1101, 1102, 1103, 1105, 1106, 1108, 1109, 1119, 1120, 1141, 1145, 1198)

1060. Ames Research Staff, Equations, tables, and charts for compressible flow, *NACA Rep.* 1135, 69 pp., 1953.

Report is a valuable addition to growing wealth of published tables and charts for compressible flow. Formulas are compiled for thermodynamic relations of perfect and imperfect gases, one-dimensional adiabatic and isentropic flow, normal shock waves, oblique shock waves, and Prandtl-Meyer expansions.

Tables present values of pressure ratio, temperature ratio, speed ratio, area ratio, etc., for isentropic flow of perfect gas with $\gamma = 1.4$, all with Mach number as argument, and extending to $M = 100$. For supersonic flow, the tables also give, for $\gamma = 1.4$, values of the Prandtl-Meyer expansion functions as well as of ratio of downstream to upstream properties for normal shock waves.

One series of charts presents, for perfect gas with $\gamma = 1.4$, numerical values of practical interest for oblique shock waves and for axisymmetric cones at supersonic speed.

A second series of charts, motivated by increasing importance of high temperatures accompanying high-speed flight, shows effects of caloric imperfections for adiabatic and isentropic stream-tube flows, for normal shocks, for oblique shocks, and for Prandtl-Meyer expansion flows. A. H. Shapiro, USA

1061. Graham, E. W., Beane, B. J., and Licher, R. M., The drag of non-planar thickness distributions in supersonic flow, *Douglas Aircr. Co. Rep.* SM-18280, 24 pp., May 1954.

For many conventional aircraft, the thickness of the wing and fuselage can be represented approximately by source distributions in the plane of the wing and on the axis of the fuselage. Such aircraft may be considered as having essentially planar thickness distributions. However, missiles with cruciform wings, biplane arrangements, "ring" wings, etc., require nonplanar source distributions to represent the wing and fuselage thickness. For this reason, the term "spatial thickness distribution" is used.

In order to simplify the investigation of spatial thickness distributions, a singularity representing an element of volume is introduced. It is shown that the optimum distribution of such elements in a prescribed space gives rise to a minimum wave-drag value consistent with that obtained for a Sears-Haack optimum body of revolution.

It is also shown that the interference of lift and side force elements with the optimum distribution of volume elements alone makes it possible to reduce the drag of a given volume below the Sears-Haack "minimum." Such interference effects (among lift force, side force, and volume elements) apparently account for the nearly zero drag of finite aspect ratio Busemann biplanes and the zero drag of Ferri's rotationally symmetrical central body plus outer shell.

In appendixes, the optimum thickness distribution for elliptical planform of given volume (first solved by R. T. Jones) is obtained through a transformation of the solution for the optimum thickness distribution for a circular wing of given volume; also derived are the ring-wing and central body of revolution combination having (a) drag of Sears-Haack body and (b) zero drag.
M. H. Bertram, USA

1062. Kavanau, L. L., Results of some base pressure experiments at intermediate Reynolds numbers with M = 2.84, *J. aero. Sci.* **21,** 4, 257–260, 274, Apr. 1954.

Base pressure data in the Reynolds number (Re_L) range from 45,000 to 400,000 are presented for a short blunt-nosed cone-cylinder body ($L/D = 3.36$, included cone angle = 60°). A maximum value of p_b/p of 0.75 occurred at $Re_L = 140{,}000$. The occurrence of such a maximum is predicted by the qualitative theory of Crocco and Lees for conditions transitioned between fully laminar and fully turbulent flow. J. Becker, USA

1063. Jorgensen, L. H., Nose shapes for minimum pressure drag at supersonic Mach numbers, *J. aero. Sci.* **21,** 4, 276–279, Apr. 1954.

Author uses pressure distribution equation of Bolton-Shaw and Zienkiewicz (English Electric Co., Rep. L.A. t.034, June 1952) to derive nose shapes of minimum drag for moderate fineness ratios and moderate supersonic Mach numbers. Author compare shapes so derived to the well-known minimum drag shapes of von Kármán and Newton, which should apply to high fineness ratio-low supersonic Mach numbers and hypersonic Mach numbers, respectively. The new shapes, although lying between the Newtonian and von Kármán, are in best agreement with the Newtonian shape. All the shapes have infinite slopes at their vertices, and all, except the von Kármán, have finite base slopes. Author notes that the presure-drag differences between the shapes at any given Mach number are small and concludes that, for most design purposes, any one of these shapes may be considered for a minimum drag nose. A. Kahane, USA

1064. Holder, D. W., and Chinneck, A., The flow past elliptic-nosed cylinders and bodies of revolution in supersonic air streams, *Aero. Quart.* **4,** part 4, 317–340, Feb. 1954.

Systematic wind-tunnel studies have been made of the flow over blunt bodies at zero incidence. The tests were conducted in a 9-in. × 3-in. induced-flow tunnel at Mach numbers of 1.42, 1.60, and 1.82 and a Reynolds number per inch of approximately 0.4×10^6. The noses of the two-dimensional plates and bodies of revolution had elliptic generators with axis ratios varying from zero (square nose) to 8.

Results are presented in the form of pressure distributions, schlieren photos, drag coefficients, and positions of bow waves and sonic points. Comparisons with theory gave fair agreement in most cases. In reviewer's opinion, the scarcity of systematic data on mixed flow phenomena makes this paper noteworthy.
R. E. Bower, USA

1065. Goroshchenko, L. B., Calculation of the flow of a gas without shock in locally supersonic zone (in Russian), *Prikl. Mat. Mekh.* **17,** 4, 423–430, July-Aug. 1953.

An adiabatic stationary and irrotational flow of nonviscous gas about circular cylinder is discussed. Assuming the velocity potential φ as $\varphi(\gamma, \theta) = \gamma\lambda_0(\theta) + \lambda_1(\theta) + \gamma^{-1}\lambda_2(\theta) + \ldots\ldots + \gamma^{-p+1}\lambda_p(\theta) + \ldots$ and $\lambda_p = \sum_{n=0}^{\infty} a_{p,2n+1} \cos(2n+1)\theta$, $a_{p,2n+1}$ are found by substituting them into the equation of motion and boundary condition in polar coordinates. The velocity components and pressure are calculated from φ thus obtained. a_{21} can be expressed as functions of $w = 2/(M_\infty^2 - 1)$, M_∞ being the Mach number. For $M_\infty > M_0 = 0.4973 \approx 0.5$, a_{21} cannot be real and a shock will be produced. $(dp/dM_\infty)_{M_\infty = M_0} = \infty$ or

$(dV/dM_\infty)_{M_\infty = M_0} = \infty$ are recommended as a criterion for shock appearance. Its justification is proved by comparing with the criterion given by A. A. Nikolisky and G. I. Taganow $(d\theta_1/dS)_{M_\infty = M_0} = 0$ [title source, **10**, 5, 1946]. It is to be noted that the velocity potential does not diverge as in other theories, but becomes imaginary for the flow with shock.

M. Kataoka, Japan

1066. **Uchida, S., Calculation of compressible cascade flow by the method of flux analysis,** *J. aero. Sci.* **21**, 4, 237–250, Apr. 1954.

A graphical method is developed for determining the compressible nonviscous flow through a two-dimensional blade cascade. This method is based on flux analysis, i.e., the solution is found by an iteration procedure, where in each step of approximation a new coordinate system is used. Choosing as coordinate lines the assumed streamlines in the channel between two cascade blades and their orthogonal trajectories, the partial differential equation of the stream function in such a curvilinear coordinate system can be reduced to an ordinary differential equation. The streamlines obtained in this way are taken as the basis for a new coordinate system. In many cases the final solution is reached after two or three steps. The inlet and outlet streamline can also be computed.

The results obtained by this method are in good agreement with exact solutions and experiments. The method described is appropriate for cascades whose streamlines do not vary too much across the width of the channel between two blades; e.g., particularly for cascades of high solidity and for inflow directions near to the ideal angle of attack of the blade. In several examples, effects of blade profile, solidity, and Mach number on flow in turbine cascades are investigated. K. Gersten, Germany

1067. **Birkhoff, G., and Walsh, J. M., Conical, axially symmetric flows,** "Mémoires sur la mécanique des fluides," *Publ. sci. tech. Min. Air, Paris*, 1–12, 1954.

Conditions are given describing the possible conical, axially symmetric, irrotational flows of a compressible, nonviscous fluid. The most general such flow belongs to a three-parameter family of which the two-parameter Taylor-Maccoll and Busemann nozzle flows are limiting cases. It is further shown that the flow must initially be parallel and supersonic and that the collapse of the receding flow to jetless parallel flow is impossible. The treatment is mathematical with little mention of applications of the results.

L. H. Schindel, USA

1068. **Pack, D. C., Laminar flow in an axially symmetrical jet of compressible fluid, far from the orifice,** *Proc. Camb. phil. Soc.* **50**, part 1, 98–104, Jan. 1954.

Using unity as Prandtl number and the assumptions for laminar boundary layer, author establishes equation for the far downstream portion of an axially symmetrical jet of compressible fluid issuing into the same fluid at rest. An iterative solution based on the known case of incompressible fluid is presented. Results show very small effect of compressibility for Mach number less than one, as to be expected from studies of compressibility on two-dimensional jets [*NACA TN* 1800]. No comparison is made with perturbation solution to same problem given by Pai [AMR 6, Rev. 200]. N. Van Le, USA

1069. **Borgnis, F. E., The equation of motion and impulse law in a viscous compressible medium** (in German), *Acustica* **4**, 4, 407–410, 1954.

The equation of motion and the hydrodynamic momentum theorem are derived vectorially from the general expression for the stress tensor in a viscous compressible medium with due consideration of the compressibility and the shear and bulk viscosities of the medium. Some remarks are added concerning the use of the one-dimensional specialization of the equations for an explanation of the hydrodynamic flow caused by acoustic waves.

From author's summary by J. H. van de Stadt, Holland

1070. **Munakata, K., On the interaction of a plane shock wave with a wedge,** *J. aero. Sci.* **21**, 7, 501–504, July 1954.

This is a preliminary report on the work carried out by the author in connection with the problem of the interaction of a shock wave with a wedge of arbitrary vertex angle. A method (due to V. Bargmann) is used in which the flow pattern is assumed to be pseudo-stationary. H. Polachek, USA

1071. **Levey, H. C., Exact solutions for transonic flow past cusped aerofoils,** *Aero. Res. Lab. Melbourne Austral. Rep.* A.87, 32 pp., Mar. 1954.

Similarly to the approach of Lighthill and Cherry in hodograph method, author obtains some exact solutions for compressible flow past a family of cusped airfoil at zero angle of attack. The solution is valid for transonic flow as long as the Mach number of the undisturbed flow upstream is subsonic and no limiting line occurs. No numerical example is given.

C.-C. Chang, USA

1072. **Mackie, A. G., One-dimensional unsteady motion of a gas initially at rest and the dam-break problem,** *Proc. Camb. phil. Soc.* **50**, part 1, 131–138, Jan. 1954.

Subject of the paper is the one-dimensional adiabatic motion of a gas being initially at rest and the corresponding dam-break problem of the hydraulic analogy. The contour integral method developed recently by E. T. Copson [*Mon. Nat. R. astr. Soc.* 110, 238–246, 1950] for strongly analytic initial conditions is extended to general analytic functions. The dam-break problem ($\gamma = 2$, γ being the adiabatic index of the gas) is discussed in detail. The method provides the solution if the function $x = f(y)$ prescribing the initial shape of the dam is analytic. Finally, a critical solution is pointed out: The r-characteristics (r, s = Riemann invariants) all pass through a point on the boundary, and the section of the dam is a parabola which touches the stream bed at its vertex. R. Sauer, Germany

1073. **Krasil'shchikova, E. A., Unsteady motion of a two-dimensional profile in a compressible fluid** (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **94**, 3, 397–400, Jan. 1954. (English translation by M. D. Friedman, 2 Pine Street, West Concord, Mass.)

Paper deals with calculation of the velocity potential of small disturbances produced in a perfect gas by a thin two-dimensional airfoil, moving at a forward speed $U(t)$ which is an arbitrary continuous function of time, and simultaneously executing arbitrary lateral motions. Author employs the mathematical analogy between unsteady two-dimensional flow and steady supersonic flow over a finite wing whose planform is related to $U(t)$ and to the airfoil chord. By transformation to characteristic coordinates, the problem is reduced to solving a succession of Abel integral equations for values of the lateral component of fluid velocity in a series of regions bounded by "Mach lines" reflected from the leading and trailing edges. Method of solution is outlined for two particular cases: airfoil starting from rest and maintaining subsonic $U(t)$; and airfoil accelerating from rest through subsonic to supersonic speeds so rapidly that no reflections of Mach lines

occur in the subsonic regime. Other applications are mentioned, including discontinuous changes in du/dt and finite variations of the airfoil chord, but no case is worked out in detail.

Reviewer does not regard the technique as substantially different from the one applied previously by several other authors to problems such as indicial motion [e.g., Lomax et al., AMR **7**, Rev. 241]. However, specific examples mentioned here have not been described before and, if carried out completely, would represent an ambitious contribution to literature on the three-dimensional analogy. H. Ashley, USA

Wave Motion in Fluids

1074. Havelock, T. H., The forces on a submerged body moving under waves. Part 1, Motion normal to the wave crests, *Trans. Instn. nav. Arch. Lond.* **96**, 2, 77–88, Apr. 1954.

A spheroid of major axis $2a$ and eccentricity e is moving axially under water with velocity V parallel to the surface. In the first part of the paper, author presents a theoretical investigation of the forces and moments on this body when there is a regular train of transverse waves, of wave length $2\pi/K$ and wave velocity c moving in the opposite direction. Author first researches the velocity potential. This potential is the sum of the velocity potential for a spheroid in a uniform stream, of the velocity potential giving the assigned train of waves moving in the negative direction, and of the velocity potential of the wave train by the spheroid. This last potential is to be determined so that the normal fluid velocity is zero over the spheroid. He then deduces the pressure equation and the resultant forces. The results, surging force, heaving force, and pitching moment, are discussed.

In the second part of the paper the same problem is solved for a submerged spheroid moving under waves at angle of attack.

L. J. Tison, Belgium

1075. Papin, V. M., Propagation of hydraulic impact along water conduits (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **93**, 5, 787–790, Dec. 1953.

Effect of water hammer can be influenced by uneven profile of a pipeline. Experiments performed on two conduits led over a hill between the pump and reservoir showed an essential reduction of impact due to formation of vacuum and discontinuance of flow at the top point. S. Kolupaila, USA

1076. Lock, R. C., Hydrodynamic stability of the flow in the laminar boundary layer between parallel streams, *Proc. Camb. phil. Soc.* **50**, part 1, 105–124, Jan. 1954.

In a previous paper [AMR **4**, Rev. 3642] author has investigated the velocity distribution of the laminar boundary layers in the neighborhood of a water surface over which a wind is blowing. He now treats the stability of such a flow starting from the linear Sommerfeld-Orr equation. This equation must be solved for both the air and the water boundary layers, so that the problem leads to eight integration constants and, therefore, needs the same number of boundary conditions.

The author seems to have overlooked that the same problem has been investigated by the reviewer [AMR **3**, Rev. 2830]. However, the methods of solution are different in both cases, author following Heisenberg's method of expansion, reviewer using the Tollmien-Schlichting method. The results of both theories agree in this point: that the minimum wind velocity to excite water waves (of 3–4 cm wave length) lies approximately at 50–60 cm/sec.

Author develops a more complicated picture of the unstable types of motion of the combined air-water system. Gravity waves must be distinguished from air waves leading to turbulence. Above a certain wind velocity, two regions of instability of gravity waves appear in the author's diagrams. Reviewer concludes from the inviscid solution in his previous paper that also a third type must exist, namely, waves leading to turbulence in the water. W. Wuest, Germany

1077. Egiazarov, I. V., Modeling of the phenomena of unsteady wave motion in unconfined and confined flows (in Russian), *Izv. Akad. Nauk SSSR Otd. tekn. Nauk* no. 10, 1417–1427, Oct. 1953.

Study of the partial differential equations shows three dimensionless similitude criteria representing Froude number, time scale, and friction, respectively, which govern modeling of unsteady free surface wave phenomena. Similarly, four criteria representing Froude number, time scale, elasticity, and friction govern modeling of unsteady flow in closed conduits.

Modeling of such flows is very fully considered in the general case and also under two simplifying assumptions, namely, (1) neglecting friction and Mach number but not elasticity, as in Joukowsky's classical water hammer theory, and (2) neglecting Mach number but not friction or elasticity. Particular attention is paid to the desirability of distorting geometric scale, the need for and feasibility of scaling the model speed of sound, and correlation with scaling of the power of the machinery. Recent papers by Larras, Devderiani, and Luniakina are briefly criticized.

Reviewer notes two material errors which do not, however, invalidate the paper as a whole: (a) in Eq. (18) the introduction of Mach number is used erroneously to eliminate the time scale criterion—it is the Froude number which should be eliminated; and (b) Eq. (20) contains a misprint.

A. H. Armstrong, England

1078. Egiazarov, I. V., Modeling of water hammer (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **92**, 3, 495–497, Sept. 1953.

A shortened version of a previous paper (see preceding review), concentrating on the classical case where friction and Mach number are neglected. In order to prevent the time scale being telescoped, it is found necessary to scale the model speed of sound by the same factor as the length of the pipe. Author finds that to do this, as Larras suggests, simply by exaggerated reduction of the pipe wall thickness, is impracticable. By using different scale factors for head, length, and diameter of pipe, however, the necessary scale factor for the velocity of sound may be kept within limits which have been shown to be practically attainable in recent experimental work by Remenieras in France and Devderiani and Luniakina in Russia. A. H. Armstrong, England

1079. Sretenskiĭ, L. N., Waves of finite amplitude caused by periodic pressure (in Russian), *Izv. Akad. Nauk SSSR Otd. tekh. Nauk* no. 4, 505–512, Apr. 1953.

1080. Heins, A. E., On gravity waves, "Fluid dynamics," Proc. Symp. appl. Math., vol. IV; New York, McGraw-Hill Book Co., Inc., 75–86, 1953.

The mathematical theory of irrotational gravity waves on the surface of an inviscid, incompressible liquid is reviewed for flows in channels of finite or infinite depths containing cylindrical obstacles with generators perpendicular to the channel. The theory is presented only for cases which may be treated by the method of Green's functions. This leads to integral equations of the Wiener-Hopf type which may be solved by means of the Fourier transform. Integral equations for the case where the submerged

obstacle is a semi-infinite rigid plane of zero thickness are derived and its reflection and transmission properties discussed.

L. Landweber, USA

1081. **Wallace, F. J., Wave action in diffusers for pipe systems: Scavenging two-stroke engines,** *Engineering* **178,** 4630, 524–528, Oct. 1954.

Diffuser is desirable for providing scavenging impulse because (1) large part of energy of pressure wave entering diffuser is transferred to the waves reflected from the diffuser wall (which are the effective scavenging waves), rather than being wasted to atmosphere by reflection from end of constant-area duct and (2) continuous reflection along passage prolongs period during which scavenging waves arrive at exhaust port. However, mathematical analysis of phenomena in diffuser is very complex.

This paper converts partial differential equations expressing constancy of mass, momentum, and energy into finite difference equations, and, on basis of certain assumptions, obtains general solution, including method of determining constants, from which pressure and velocity distributions and state of fluid inside diffuser can be calculated.

Numerical analysis of three different diffusers is given, showing more effective impulse with diffuser, regardless of its dimensions or configuration, than with constant-area duct. Efficiency (defined as difference between energy of fundamental impulse and energy rejected to atmosphere, divided by energy of fundamental impulse) is shown to be more than 99% for all three diffusers, as compared with 38% for comparable duct of constant area. However, friction limits the gains otherwise possible from long diffuser.

C. W. Smith, USA

1082. **Hubbard, H. H., and Lassiter, L. W., Oscillating pressures near a static pusher propeller at tip Mach numbers up to 1.20 with special reference to the effects of the presence of the wing,** *NACA TN* **3202,** 35 pp., July 1954.

Static tests were conducted for the measurement of free-space oscillating pressures near the propeller in the region where a wing might be located for the tip Mach number range of 0.50 to 1.20. Some measurements were also made near the tips in the region of the fuselage in order to extend the range of existing work from a tip Mach number of 1.00 to 1.20. Some comparisons of these results with theory are given. In addition to a description of the free-space pressure field, measurements are given for some of the same field points with a wing in place. Charts based on experimental data are presented to enable a designer to estimate the maximum free-space oscillating pressures near the propeller for tip Mach numbers up to 1.20.

From authors' summary

Turbulence, Boundary Layer, etc.

(See also Revs. 1076, 1134, 1174, 1194, 1223, 1227)

1083. **Görtler, H., On the three-dimensional instability of laminar boundary layers on concave walls,** *NACA TM* **1375,** 32 pp., June 1954. (Translation from *Ges. d. Wiss. Göttingen, Nachr. a. d. Math.* **2,** no. 1, 1940.)

Author studies the stability of laminar boundary-layer profiles on slightly curved walls relative to small disturbances, in the shape of vortexes, whose axes are parallel to the principal direction of flow. The result is an eigenvalue problem by which, for a given undisturbed flow at a prescribed wall, the amplification or decay is computed for each Reynolds number and each vortex thickness. For neutral disturbances (amplification null), a critical Reynolds number is determined for each vortex distribution. The numerical calculation produces amplified disturbances on concave walls only. The results yield information about stability limit, range of wave length of vortexes that can be amplified, and about the most dangerous vortexes with regard to the transition from laminar to turbulent flow. At the very first appearance of amplified vortexes the flow still is entirely regular; transition to turbulent flow may not be expected until the Reynolds numbers are higher.

From author's summary by K. Pohlhausen, USA

1084. **Bradfield, W. S., DeCoursin, D. G., and Blumer, C. B., The effect of leading-edge bluntness on a laminar supersonic boundary layer,** *J. aero. Sci.* **21,** 6, 373–382, 398, June 1954.

An experimental investigation of a flat plate in an air stream at a Mach number of 3.05 revealed important effects of leading-edge bluntness on laminar boundary layers. The detached shock wave resulting from a blunt leading edge causes thickening of the boundary layer and reduces the slope of the velocity profiles relative to the theoretical values expected in the idealized or shockless case. Ratio of leading-edge thickness to theoretical value of boundary-layer displacement thickness at the measuring station serves as a criterion for the magnitude of the effects. These effects are shown to be independent of the effects of heat transfer and pitot tube size. Authors conclude that the presence of a detached leading-edge shock wave is responsible for the observed discrepancy between theoretically predicted and measured momentum losses.

Similar tests on a 15-deg cone show that blunting the tip does not seriously affect the laminar boundary layer.

G. J. Nothwang, USA

1085. **Jedlicka, J. R., Wilkins, M. E., and Seiff, A., Experimental determination of boundary-layer transition on a body of revolution at** $M = 3.5$, *NACA TN* 3342, 56 pp., Oct. 1954.

Boundary-layer-transition tests were made in free flight through still air on a small-scale fin-stabilized body of revolution of fineness ratio 30 at a Mach number of 3.5 and length Reynolds numbers of 12 and 24 million. Three types of surfaces were tested and the transition Reynolds number was found to depend critically on the surface smoothness. Angle of attack was found to influence transition strongly. This effect was correlated in terms of pressure rise along streamlines and led to a prediction of the effect of varying the body shape on sheltered-side transition. In general, the transition points were time-dependent, fluctuating in one case over a range of Reynolds numbers from 4 to 20 million. Steady laminar flow was observed to a length Reynolds number of 11 million. Transition due to roughness and adverse pressure gradient occurred, even though the tests were within the region of theoretical infinite laminar stability to small disturbances.

From authors' summary

1086. **Czarnecki, K. R., and Sinclair, A. R., Preliminary investigation of the effects of heat transfer on boundary-layer transition on a parabolic body of revolution (NACA RM-10) at a Mach number of 1.61,** *NACA TN* 3165, 23 pp., Apr. 1954.

1087. **Czarnecki, K. R., and Sinclair, A. R., An extension of the investigation of the effects of heat transfer on boundary-layer transition on a parabolic body of revolution (NACA RM-10) at a Mach number of 1.61,** *NACA TN* 3166, 21 pp., Apr. 1954.

These two papers summarize the results of a careful experimental investigation of the effect of heat transfer on boundary-layer transition. The tests were conducted on a parabolic body of revolution at $M = 1.61$. The Reynolds number range (based on body length) was from 2.5×10^6 to 35×10^6.

The tests showed the transition Reynolds number to be extremely sensitive to body temperature, which was varied by heat-

ing and cooling the model. A maximum transition Reynolds number of 28.5×10^6 was obtained, which is considerably higher than had previously been attained in wind-tunnel tests.

J. R. Stalder, USA

1088. Hyman, M. A., On the correlation function in Burgers' model of turbulence, *Appl. sci. Res.* (*A*) **4,** 5/6, 361–373, 1954.

Paper describes a numerical investigation of the dynamical equation for the velocity correlation function in the one-dimensional model of turbulence put forward by Burgers [AMR **2,** Rev. 775]. G. K. Batchelor, England

1089. Gadd, G. E., Interactions between wholly laminar or wholly turbulent boundary layers and shock waves strong enough to cause separation, *J. aero. Sci.* **20,** 11, 729–739, Nov. 1953.

Paper is primarily a semiempirical treatment of the interaction between a laminar or turbulent boundary layer on an insulated flat plate and an incident oblique shock wave strong enough to cause separation. A detailed qualitative interpretation of the phenomenon is given, based on the picture of an interaction between an external supersonic inviscid flow and a dissipative boundary-layer flow near the plate surface. For the laminar boundary layer, the velocity profile is approximated by a sine function, the boundary conditions satisfying an isentropic interaction pressure gradient; this allows the determination of the pressure ratio at separation. For the turbulent boundary layer, a power law profile is assumed upstream of the shock, and the increase of pressure to separation is considered to be that brought about by bringing to rest without friction the fluid at the "shoulder" of the profile, taken at 0.6 of free-stream velocity. Relations for the turbulent layer are obtained for the over-all effects, when the shock is sufficiently strong to cause a large extent of separated flow. Assumptions as to the velocity profile a short distance downstream of the reattachment point, as well as to the mixing rate, are required. Comparison with experimental results for the separation pressure ratio and extent of the "influence region" are made for the turbulent case.

Reviewer feels paper to be an excellent presentation of subject. In a note by Bogdonoff [title source, **21,** 2, 138–139, Feb. 1954] it was pointed out, and acknowledged by Gadd and Holder [ibid., **21,** 8, 571–572, Aug. 1954], that the experimental values presented for turbulent separation pressure ratios were too high. Bogdonoff's note also raises the question as to the validity of turbulent interaction distance data, upon which rest many of the empirical constants. Reviewer takes exception with the author in believing that there is a fundamental difference between a separating supersonic laminar and turbulent boundary layer on a flat plate as evidenced by the gradual increase in pressure for the laminar case in contrast to the turbulent layer, which always experiences a sudden pressure rise. This difference can be discussed on physical grounds. R. F. Probstein, USA

1090. Truckenbrodt, E., Turbulent boundary layer at the surface of a rotating disk (in German), *ZAMM* **34,** 4/5, 150–162, Apr./May 1954.

Author investigates the turbulent boundary layer at the surface of a rotating disk in a uniform stream parallel to the axis of rotation. Applying the method of the momentum equation given by von Kármán for the rotating disk in a fluid at rest, author derives approximate formulas for the velocity distribution, the thickness of the turbulent boundary layer, the frictional moment, and the shearing stresses at the disk and discusses the results as function of the ratio of the fluid velocity and the angular velocity of the disk. K. Pohlhausen, USA

1091. Stephens, A. V., and Collins, G. A., Turbulent boundary layer control by ramps or wedges, *Aero. Res. Lab. Melbourne Austral. Rep.* A.85, 28 pp., 28 figs., Apr. 1954.

Report deals with the delay of turbulent boundary-layer separation by means of uniformly spaced wedges or ramps fixed to the upper surface of a wing. Tests on this type of boundary-layer-control device were conducted in a 28-in. × 20-in. N.P.L. wind tunnel at 80 fps, in a 7-ft × 5-ft wind tunnel at 130 fps (chord Reynolds number of 3.3×10^6, 50-in. chord), and in actual flight on a Mustang-type aircraft. Static and pitot pressure distributions are given. Flow visualization using goose feather and emu feather tufts are reproduced.

Improvements in lift characteristics are noted. This is attributed to the production of vortexes from the sharp upper edges of the wedges or ramps which increase the transport of momentum to the lower regions of the boundary layer. Empirical data are given for the design and location of such ramps or wedges, as applied to a wing or a wing-flap combination.

The flight experiment confirmed the wind-tunnel results that in most cases the advantage of decreased form drag owing to the delay of turbulent separation was materially reduced by the increase in drag due to the wedges or ramps.

I. I. Glass, Canada

1092. Nigam, S. D., Note on the boundary layer on a rotating sphere, *ZAMP* **5,** 151–155, 1954.

On a rotating sphere the boundary layer originates at the poles and flows out near the equator. The solution of this problem given by Howarth [AMR **5,** Rev. 1156] does not give satisfactory results near the equator. Author constructs a solution in power series form quite sufficient to describe the interaction at the equator. A. Betz, Germany

1093. Fadnis, B. S., Boundary layer on rotating spheroids, *ZAMP* **5,** 2, 156–163, 1954.

The solution of boundary-layer problem on a rotating sphere given by Howarth [AMR **5,** 1156] and Nigam (see preceding review) is generalized to rotating prolate and oblate spheroids.

A. Betz, Germany

Aerodynamics of Flight; Wind Forces

(See also Revs. 919, 920, 999, 1034, 1061, 1119, 1122)

1094. Sears, W. R., editor, General theory of high speed aerodynamics (High speed aerodynamics and jet propulsion, Vol. VI), Princeton, N. J., Princeton Univ. Press, 1954, xiv + 758 pp. $15.

This collective work will gradually come out in twelve volumes. Vol. VI has just appeared as one of the first. W. R. Sears, who is also a co-author, is the special editor of vol. VI. The several contributions of all seven co-authors are of unequal value. Sears states, regarding the contribution of M. J. Lighthill: "The piece of work is unique in aeronautical literature and should be an especially valuable feature of this volume." Quite so. Lighthill contributes a masterly written mathematical exposition, unique in this volume. But most other contributions are also fairly well done. A major contribution by M. A. Heaslet and H. Lomax is a particularly neat piece of work. The only exception is perhaps the introduction to "Methods of characteristics." That can hardly be considered a masterpiece. For instance, the definition of characteristic surfaces, p. 584, is unacceptable and misleading. "Characteristic solutions" are then mentioned but not defined; that term is foreign to those skilled in the art. On p. 587, we

read finally with amazement: "The velocity of sound . . . depends on the direction of the line along which it is computed." How shall the sound waves then know how to govern themselves? Let no one think that the velocity of sound may in any way depend on the direction of the sound waves. It does not. Later on, the going is better in this contribution.

It is interesting to speculate on how far vol. VI is representative of the whole series of twelve volumes. The Editorial Board for the entire series, with von Kármán as its chairman, "is confident that the present series . . . will have far reaching beneficial effects on the further development of the aeronautical sciences." Aeronautical design is not mentioned in this connection. This confidence is most probably aroused by the precedent of Durand's "Aerodynamic theory," written twenty years ago. That had indeed such effects on the development of aeronautical science and design alike; that collective work was an outstanding success. This did not just happen by accident. Dr. Durand devoted strenuous work to his series through several years. He saw to it with vigor that the authors proceeded in the right direction and that the several contributions were well coordinated. He followed up every detail and in person checked every line and equation. He never lost sight of a clear aim and purpose. Durand states: "The chief purpose held in view of this (Durand's) project has been to provide for the student and for the aeronautical designer a reasonably adequate presentation of the background theory." Accordingly, Durand, himself an engineer, selected authors who had close contact with aeronautical design. Durand achieved his purpose splendidly by reason of his genius for enlightened planning and in consequence of his great devotion and diligence. Year in and year out Durand's "Aerodynamic theory" continues to make good and instructive reading for the student and for the designer alike.

The preface of "High speed aerodynamics" is not as specific about the purpose of the new series. It seems that the individual authors of vol. VI were very much on their own on how to select the readers for whom they wanted to write. It is unlikely that they gave any thought to that question. Being specialists in narrow fields, and being accustomed to communicate their results and findings to specialists of their own kind, they naturally did the same thing again. Vol. VI is accordingly addressed to people who could have written it. The individual contributions are incomplete summaries of special lines of theoretical research. It is quite nice to have them, and they make things easier for newcomers preparing themselves to continue such special research. But there is no crying need for Vol. VI. People actively working along these lines have to establish collections of reference papers. Vol. VI does not eliminate that need. But the collections eliminate most of the need for Vol. VI. Also, the number of people throughout the entire nation to whom the papers are directed is extremely small.

At any rate, vol. VI is not written for engineers and is not suitable for being read by them. The papers are too remote from engineering reality. Practical examples and references to design questions are more or less absent. Some aeronautical engineers have already tried in vain to read vol. VI. They found it unreadable for them. Vol. VI tends to present itself to the engineer as an endless and dreamy parade of shadowy and colorless mathematical statements. In that most important and essential respect, vol. VI of "High speed aerodynamics" is very different from the volumes of Durand's "Aerodynamic theory."

Times have changed since Durand's volumes were written. Aerodynamic research has assumed the proportion of a major industry. The number of papers that have appeared, and which continue to be produced, is staggering. Aeronautical inquiry reaches into all fields of scientific knowledge. Whereas Durand's six volumes having about 2000 pages were adequate twenty years ago, twelve volumes having about 9000 pages written in an analogous manner are frightfully inadequate today for getting together a sufficiently clear and complete summary. The attempt to do so is hopeless from the beginning. The problem has to be attacked in an entirely different manner. We can no longer create a substitute for a collection of the pertinent papers. We can only prepare, and we badly need, a good guide to find the papers. We need a well-arranged, cleverly classified, and reasonably complete collection of abstracts, such as are already available scattered around with citation lists, additional connecting annotations, and a very full index. Even in vol. VI, the reference lists, incomplete as they may be, are the most valuable portions of the book. This reviewer wishes that the funds for preparing such a book of abstracts may soon become available. The needs of twenty years ago are no longer the needs of today. The times change, and we have to change with them.

M. M. Munk, USA

1095. Harleman, D. R. F., and Ippen, A. T., The range of application of the hydraulic analogy in transonic and supersonic aerodynamics, "Mémoires sur la mécanique des fluides," *Publ. sci. tech. Min. Air. Paris*, 91–112, 1954.

Numerical calculations show hydraulic analogy best represents pure supersonic flow with shock waves when hydraulic depth ratio is assumed equal to density ratio of corresponding compressible gas flow. The specific heat ratio (γ) is not used directly in the analogy but is introduced only when computing the pressure and Mach number corresponding to the density ratio assumed equal to the measured hydraulic depth.

However, in the transonic case, shock waves are weak and the entire flow field nearly isentropic, so $\gamma = 2$ is the predominant aspect. The measured hydraulic depth is again taken equal to density ratio, but pressure and Mach number must now be calculated using $\gamma = 2$. The results can then be applied to a real gas flow by using transonic similarity laws.

Reviewer emphasizes that for all continuous potential flow regions (especially when subsonic), $\gamma = 2$ must be used throughout analogy and, as previously pointed out [AMR **5**, Rev. 3478], in this case the effect of water depth on group velocity is extremely important, so model must be as large as possible and water depth less than $^1/_4$ in. for the best analogy.

As would be expected, group velocity would have an effect even in the supersonic case of isentropic expansion. This is illustrated in the experimental data in Fig. 7. Since the water depth is 0.95 in., even a 3-ft model does not give results agreeing with the analogy based on negligible vertical accelerations. If a $^1/_8$-in. water depth could be used, a smaller model would give closer agreement. The effect of model size as shown in Fig. 7 is determined by the group velocity corresponding to the longer wave lengths produced by the larger model size and is not related to a Reynolds number effect.

E. V. Laitone, USA

1096. Shaw, R. A. Changes in control characteristics with changes in flow pattern at high subsonic speeds. Test on an EC. 1250 aerofoil with 25 per cent concave control flap. Parts I and II, *Aero. Res. Counc. Lond. Rep. Mem.* 2436, 32 pp., Apr. 1949, published 1954.

Report describes results obtained in wind-tunnel tests where it was found that considerable changes in flow pattern and pressure distribution around an airfoil with control flap occurred in certain conditions for a small increase in speed or change in incidence or control angle. The changes were found first between $M = 0.85$ and 0.87, when the shock-stalled flow, which had developed at lower speeds, was replaced, on one surface only, by streamline flow extending almost to the trailing edge. When the flow ad-

hered in this way, an inclined shock wave or Prandtl-Meyer flow was established at the flap hinge which deflected the flow smoothly along the flap. The changeover to this regime took place for a change in speed M of only about 0.01 to 0.03 and was accompanied by very large changes in the pressure distribution over the rear of the airfoil and on the flap. These regimes were established only when the pressure distribution over the surface was favorable ahead of the hinge and appeared to require a local Mach number of about 1.25 for the Prandtl-Meyer and 1.4 for the hinge-shock regime.

Evidence of similar behavior has been found in American tests on a 19% thick airfoil at $M = 0.74$ and in German tests on a 9% thick airfoil at $M = 0.88$, the local Mach number for both being about 1.4 as in the present tests.

Some of the experiments were repeated later with the boundary layer made turbulent. The results show that adhesion of flow in this way is not specially a laminar-flow phenomenon but can occur in the same conditions at the same speed when the boundary layer is turbulent. An example has been obtained of adhesion of flow on both surfaces of the airfoil at once in conditions which were favorable for both types of adhesive flow.

It is suggested that the speed zone between flow adhering on one and on both surfaces is a danger zone in transonic flight, but with more information designers may be able to spread the effects along the span and so avoid any serious control problems from this cause. From author's summary

1097. Keune, F., and Oswatitsch, K., Low-aspect-ratio bodies at zero lift in subsonic and supersonic flow (in German), *Z. Flugwiss.* **1**, 6, 137–145, Nov. 1953.

If the changes of the perturbation potential in the chord direction are small, the linearized three-dimensional equation for the velocity potential can be approximated by the two-dimensional Laplace equation for the flow in transverse planes near the body. Far away from the body, the subsonic flow can be represented by a doublet, while supersonic flow becomes parallel flow. In the intermediate zone, authors compare the equipotential lines of a cross section with those of a body of revolution and replace the actual body by an "equivalent body of revolution"; an incompressible flow with appropriate source distribution must be added. The source strength in each cross section corresponds to the change of the cross-sectional area. This new method is applicable to Mach numbers remarkably close to 1 and leads to great simplifications, especially in the computation of the influence of Mach number changes and of the drag coefficient.

A thorough review of thin-wing and slender-body theory and the calculation of an example are very valuable; the latter gives curves of equal velocity over a 6% thick delta wing with cut-off wing tips at Mach numbers 0; 0.916; 1.077; $2^{1}/_{9}$.

G. R. Graetzer, USA

1098. Neumark, S., and Collingbourne, J., Velocity distribution on thin tapered wings with fore-and-aft symmetry and spanwise constant thickness ratio at zero incidence, *Aero. Res. Counc. Lond. Rep. Mem.* no. 2858, 43 pp., June 1951, published 1954.

This report is a continuation of AMR 6, Rev. 1691 and AMR 7, Rev. 1364. The first-order method of linear perturbation is used to derive the velocity distribution on thin straight tapered wings at zero incidence. The method given is quite general, but calculations have only been performed for wings with zero sweep back of the midchord line, having biconvex sections. The general formula for the supervelocity involves logarithmic integrals; these are expanded in convergent power series, and are transformed into rapidly convergent series suitable for computation. Formulas are given in terms of three geometric parameters—the taper ratio, the angle of sweep back of the midchord line, and the coefficient of convergence ϵ (the rate of decrease of the semichord with the spanwise coordinate).

It is shown that for unswept wings with biconvex parabolic profile the maximum supervelocity for any chordwise section occurs at the midchord point. The maximum supervelocity at the center section decreases as the aspect ratio decreases and as the wing becomes more highly tapered. However, in general, supervelocity increases for tapered wings as we move outboard along the midchord line. For completely tapered (rhombus) wings the theory predicts a logarithmically infinite supervelocity when the tip is approached along the midchord line. This singularity has been obtained using the linear theory, and the results of an exact theory may be different.

For an unswept wing not tapered to a point (cropped rhombus) there is a considerable reduction of the maximum supervelocity toward the tips. However, in the best case, there is only a slight reduction in over-all maximum supervelocity as compared with a rectangular wing.

Isobar patterns have been calculated for two tapered wings, one of which is tapered to a point. The flow at the center section is mainly affected by the angle of taper ϵ. For the wing tapered to a point all the isobars converge to the tip. For the cropped rhombus wing the higher isobars become narrow ovals in each half wing enclosing the point of over-all maximum supervelocity. For this wing the flow at the tips resembles that at the tips of a rectangular wing.

Change of profile would produce modifications in the above in destroying the fore and aft symmetry, but no important qualitative changes are to be expected for well-shaped profiles.

A. W. Babister, Scotland

1099. Gullstrand, T. R., Transonic flow past two-dimensional aerofoils, *Z. Flugwiss.* **1**, 2, 38–46, July 1953.

Résumé is given of author's work on calculation of distribution of surface pressure at supercritical subsonic speeds [AMR 5, Rev. 1472; 6, Revs. 1970, 2294, 3479]. Approach is based on transonic small-disturbance theory and utilizes integral equation in physical plane as first proposed by Oswatitsch [AMR 4, Rev. 302; see also K. Oswatitsch, "Gasdynamik," Springer, Wien, 1952, p. 362 ff]. Solution, which is obtained by iteration process, involves several special assumptions regarding nature of flow field and shock system. Reasonable-looking results are shown for a parabolic-arc airfoil at zero lift and at small angle of attack. Paper closes with simple and very approximate method for estimating characteristics of airfoils in transonic speed range. For further consideration of integral-equation approach and iteration process, reader should also consult recent paper by Spreiter and Alksne [AMR 7, Rev. 3630].

W. G. Vincenti, USA

1100. Sauer, R., Application of the distribution theory to the problem of supersonic wings (in German), "Mémoires sur la mécanique des fluides," *Publ. sci. tech. Min. Air, Paris*, 289–308, 1954.

The distribution theory of Schwartz has made it possible for the usual processes of analysis to be applied to functions with certain types of discontinuities. The author gives a summary of this theory, paying special attention to Heaviside's step function and Dirac's δ function, and applies it to obtain the well-known integrals giving the velocity potential of linearized supersonic flow past a thin wing in terms of a source and a doublet distribution over it. It is claimed that the derivation is more satisfactory than that using Hadamard's theory of the finite part of an infinite integral.

K. Stewartson, England

1101. **Lean, G. H., Report on the flow phenomena at supersonic speed in the neighbourhood of the entry of a propulsive duct,** *Aero. Res. Counc. Lond. Rep. Mem.* 2827, 15 pp., Mar. 1945, published 1954.

1102. **Roper, G. M., The pressure distribution, at supersonic speeds and zero lift, on some swept-back wings having symmetrical sections with rounded leading edges,** *Aero. Res. Counc. Lond. Rep. Mem.* 2700, 20 pp., Feb. 1949, published 1954.

Use is made of the methods of Robinson [*Rep. Mem.* 2548] for obtaining solutions of the linearized differential equation of supersonic flow in terms of the Lamé functions. Author shows how these solutions may be applied to obtain pressure distributions at supersonic speeds and at zero incidence for certain symmetric surfaces of small finite thickness—with leading edges swept behind the Mach cone. While the technique provides a reasonable solution for the pressures over the flat surfaces of the wing where $v'/u_\infty \ll 1$, the linearized theory is not valid in regions of the rounded leading edge. Hence, the nature of the pressure distributions at or around such an edge determined by linear theory is questionable.

Reasonable estimates of the form drag are obtained, however, by integrating the linearized pressures over the wing and including the drag due to leading edge force given by Jones [*J. aero. Sci.*, May 1950]. S. Lampert, USA

1103. **Nociila, S., On an aerodynamic problem related to delta wings** (in Italian), *Atti Accad. naz. Lincei R. C. Sci. Fis. Mat. Nat.* (8) **15,** 3/4, 179–186, 1953; *Monogr. Lab. Aero. Politecn. Torino* no. 325, 1954.

Author considers a delta wing with dihedral, in supersonic flow with its leading edges inside the Mach cone, and investigates the lift distributions due to small angles of incidence and yaw, respectively. These are calculated in the form of series in powers of the dihedral angle; two terms of such a series are found for each lift distribution, so that if all four terms are used the expression neglects only the fourth power of the dihedral angle (apart from any errors involved in the use of the familiar linearized theory). M. J. Lighthill, England

1104. **Spreiter, J. R., On the application of transonic similarity rules to wings of finite span,** *NACA Rep.* 1153, 21 pp., 1953.

Supersedes article reviewed in AMR **5,** Rev. 3480.

1105. **Abbott, I. H., Some factors contributing to scale effect at supersonic speeds,** *AGARD Mem.* AG8/M4, London AGARD Conf., Sept. 3–11, 1953.

1106. **Gullstrand, T. R., Energy conditions when flying at supersonic speeds** (in Swedish), *Tekn. Tidskr.* **84,** 24, 781–784, Sept. 1954.

It is shown that the kinetic energy is of the same order of magnitude as the height energy, when an airplane is flying at supersonic speed. It is therefore necessary to take the kinetic energy into account when calculating the best climbing technique, which was first shown by Kaiser, 1944 [RPT/TIB Transl. GDC/148 T]. A climb of an airplane capable of supersonic speed can include a dive through the transonic speed region. The influence of an additional rocket engine is discussed. From author's summary

1107. **Sedney, R., On Jones's criterion for thin wings of minimum drag,** *J. aero. Sci.* **21,** 9, 639–640, Sept. 1954.

1108. **Bailey, H. E., and Phinney, R. E., Wing-body interference. Part I. Theoretical investigation,** *Engng. Res. Inst., Univ. of Mich., Ann Arbor, Rep.* 1937-1-F, 18 pp., Jan. 1954.

Nielsen's method for determining the linearized supersonic flow theory solution for wing-body combinations is reviewed and applied to lifting configurations. Specific results are given for a rectangular flat-plate wing mounted on an infinite cylindrical body of revolution. J. R. Spreiter, USA

1109. **Bailey, H. E., and Phinney, R. E., Wing-body interference. Part II. Experimental investigation of cylindrical model,** *Engng. Res. Inst., Univ. of Mich., Ann Arbor, Rep.* 1937-2-F, 62 pp., Feb. 1954.

Results of pressure-distribution measurements at a Mach number of 1.90 on a rectangular-wing cylindrical-body configuration are presented and compared with those computed using the method described in part I (see preceding review). The experimental results agree quite well with the predictions of linear theory, but it is noted that the agreement can be improved by shifting the positions of the shock jumps to the locations predicted by simple shock-wave theory. A number of interesting viscous effects are discussed and illustrated with china-clay patterns. J. R. Spreiter, USA

1110. **Bailey, H. E., and Phinney, R. E., Wing-body interference. Part III. Experimental investigation of body simulator plate,** *Engng. Res. Inst., Univ. of Mich., Ann Arbor, Rep.* 1937-3-F, 47 pp., Feb. 1954.

Tests were conducted at $M_0 = 1.90$ of a wing placed next to a plate of limited longitudinal extent intended to simulate a body. The effect of gap between the wing and the body simulator plate was investigated for three gap sizes in addition to the zero-gap case. When possible, the results are compared with those calculated using simple shock-wave and Prandtl-Meyer flow theory.
J. R. Spreiter, USA

1111. **Murphy, C. H., Effect of roll on dynamic instability of symmetric missiles,** *J. aero. Sci.* **21,** 9, 643–644, Sept. 1954.

This note attempts to extend the discussion by stating a slightly neater form of generalized stability conditions and describing certain experimental results on dynamic instability.
From author's summary

1112. **Roy, M., Lateral stability of flight and some research performed at ONERA** (in French), *ONERA Publ.* no. 69, 28 pp., June 1954.

This address to the French aeronautical engineering society, with the discussion maintained largely on a narrative plane, is interesting and stimulating due to the profound experience and keen conceptual instincts of the author, who is director of the "Office National d'Études et de Recherches Aéronautiques" (ONERA).

The descriptive material presented is familiar to specialists; otherwise, the coverage is not in sufficient detail to be directly useful. ONERA has apparently done very extensive development of balances and instrumentation for model stability studies in free flight and tunnel. Account indicates high order of theoretical attention to test details. Indications are that frequency-response techniques and unpiloted models with tele-command and telemetering play a big role in French stability research.

Unfortunately no references are included to provide leads to interesting material described. Author considers culmination of aerostability efforts will be the union with aero-vibration and aerodistortion aspects into a true "general stability of the movements and forms of the airplane in its flight."
P. R. Hardesty, USA

1113. Savitsky, D., and Dingee, D. A., Some interference effects between two flat surfaces planing parallel to each other at high speed, *J. aero. Sci.* **21,** 6, 419–420, June 1954.

1114. Liepmann, H. W., Extension of the statistical approach to buffeting and gust response of wings of finite span, *Douglas Aircr. Co. Rep.* SM-15172, ii + 14 pp., Feb. 1954.

An expression is derived for the mean-square-lift of a finite three-dimensional airfoil in a turbulent flow in terms of the admittance of the airfoil and the power spectrum of the turbulence.

A number of simplifying assumptions are considered, and explicit results are obtained for isotropic turbulence which reduce to a previously published result in the case of a wing small compared to the scale of the turbulence. No numerical or experimental results are given for the more general cases. W. Squire, USA

1115. Hoblit, F. M., An approximate method for determining the effects of wing twist on airplane gust loads, *J. aero. Sci.* **21,** 9, 641–643, Sept. 1954.

The purpose of this note is to show that a "common-sense" approximate procedure gives results that agree very closely with those obtained by the more precise theory and hence may be useful for cases not covered in AMR **7,** Rev. 2937.

From author's summary

1116. Hafner, R., The domain of the helicopter, *J. roy. aero. Soc.* **58,** 526, 663–702, Oct. 1954.

Brief outline of the past history of the helicopter is followed by considerations of present problems, and paper concludes with a glance into the future. Referring to the present status of helicopters, the following problems are either discussed or outlined in broad strokes: (a) Performance limitations due to blade stall and compressibility effects; (b) blade drag fluctuation in forward flight; (c) power required in different regimes of flight; and (d) rotor configurations considered in the light of structural weight of blades, systems of power source, and types of transmission, etc. Finally, possible domains of application of the three basic types of helicopters (pure, compound, and convertible) are considered, with special emphasis on their suitability as means of public transportation.

The author has succeeded in presenting, in one lecture, the actual state of the art of rotating-wing aircraft, as well as giving some idea as to the possible impact of helicopters on the field of public transport. W. Z. Stepniewski, USA

Aeroelasticity (Flutter, Divergence, etc.)

(See also Revs. 976, 999, 1082)

1117. Duncan, W. J., Stability criteria for the octic equation, *J. roy. aero. Soc.* **58,** 525, 649–650, Sept. 1954.

Author extends previous developments for application to the octic linear differential equation with constant coefficients. A computational outline is proposed. Theory can be applied to quaternary flutter studies, and method is developed for direct calculation of the flutter frequency in the critical state.

J. B. Duke, USA

1118. Duncan, W. J., Stability criteria, with special reference to the sextic equation, *J. roy. aero. Soc.* **58,** 522, 431–433, June 1954.

The stability criteria for linear differential equations with constant coefficients are discussed in terms of a critique on "necessary" and "sufficient" conditions.

Author develops a set of test determinants after the methods of Routh, and Frazer, and Hurwitz for a sextic equation, and based upon critical criteria for stability. Development of these criteria proves that previous assertions on the stability of the sextic equation are inaccurate.

Theory has application to ternary flutter studies.

J. B. Duke, USA

1119. Timman, R., van de Vooren, A. I., and Greidanus, J. H., Aerodynamic coefficients of an oscillating airfoil in two-dimensional subsonic flow, *J. aero. Sci.* **21,** 7, 499–500, July 1954.

Numerical values for the aerodynamic coefficients of an oscillating wing in two-dimensional subsonic flow, calculated by aid of an analytical solution in terms of Mathieu functions, have been published by the authors [AMR **5,** Rev. 1475; **6,** Rev. 3176]. Considerable question regarding the accuracy of these values was put forward by Fettis [title source, **19,** 5, 353–354, May 1952] and Jordan [ibid., **20,** 5, 362–363, May 1953].

This error has been eliminated, and revised values satisfying the reciprocity relation up to a few units in the fifth decimal figure are now available. Ed.

1120. Van Dyke, M. D., On supersonic flow past an oscillating wedge, *Quart. appl. Math.* **11,** 3, 360–363, Oct. 1953.

The flow about a thick wedge performing small angular oscillations around its apex was worked out by Carrier. Author extends this solution to include an arbitrary position of the pivot. The object of the paper is to illustrate the nonlinear effects of thickness by comparing the exact solution with those given by linear and second-order theories.

The method used is to superpose a linearized unsteady flow upon the exact, nonlinear, steady flow field, supposing the Mach number is high enough for the shock wave at the apex to remain attached throughout the motion.

An explicit solution is given for slow oscillations and includes expressions for the normal force and pitching moment on a wedge of finite length. As a special case, for a finite wedge of 5° semivertex angle, numerical values of the Mach number at which the aerodynamic damping moment vanishes (stability boundary) are presented in terms of pivot position, ranging from the base of the wedge to $1^1/_2$ chord lengths ahead of the apex. Comparison is made with the corresponding result given by the author's second-order theory, and with linear theory. The agreement between the exact and second-order theories is excellent; on the other hand, the stability boundary given by linear theory is lower by roughly 0.2 in Mach number. P. R. Owen, England

1121. Jones, W. P., Note on the estimation of aerodynamic forces on oscillating aerofoils in two dimensions, "Mémoires sur la mécanique des fluides," *Publ. sci. tech. Min. Air, Paris,* 143–152, 1954.

Discrepancies between theory and experiment for unsteady motion are reduced by combining techniques. Aerodynamic forces in steady flow for the specific airfoil are obtained experimentally and furnish coefficients for downwash relations in unsteady flow, using an equivalent profile method. Improved agreements with experiment are shown for an airfoil oscillating near a stall, an airfoil with oscillating control surfaces, and an airfoil oscillating in compressible flow. Extension to three-dimensional derivatives is believed possible. E. T. Welmers, USA

1122. Coles, A. V., and Margetts, R. J., An investigation into the rolling power and aileron reversal characteristics of swept wings, *Aero. Res. Counc. Lond. curr. Pap.* no. 159, 18 pp., 10 figs., 1954.

Study is made of the effect of sweep for the aeroelastic wing-

aileron combination at low speeds. Models included six semispan wings with sweep angle varying from −15° to 60° in 15° increments. Wind tunnel was a 3½-ft open jet. Theory is presented for determining reversal speeds. Results indicate that the rolling power decreases with increasing speed in an approximate parabolic manner, with sweep producing no basic changes; the curve flattens with increasing sweep since the swept wing initially has less rolling power than the straight wing. The predicted reversal speeds show good agreement with the experimental results, both indicating that reversal speed of swept wings will increase with increase of sweepforward or sweepback.

J. De Young, USA

1123. **Lance, G. N., The kernel function of the integral equation relating the lift and downwash distributions of oscillating finite wings in subsonic flow,** *J. aero. Sci.* **21,** 9, 635–636, Sept. 1954.

1124. **Diederich, F. W., A note concerning the effect of wing twist on the response of a wing to a sharp-edged gust,** *J. aero. Sci.* **21,** 9, 636–637, Sept. 1954.

1125. **Lyford, R. B., An approximate method for calculating preliminary airplane aeroelastic effects,** Proc. First Midwestern Conf. Solid Mech., Engng. Exp. Sta., Univ. of Ill., 95–98, Apr. 1953.

The iteration method for estimating aeroelastic effects on spanwise lift distribution is presented without making clear the limitations of the analysis or the fact that superior sources of information on this subject exist in the open literature.

H. R. Lawrence, USA

1126. **Schnittger, J. R., Single degree of freedom flutter of compressor blades in separated flow,** *J. aero. Sci.* **21,** 1, 27–36, Jan. 1954.

Method of Halfman et al. [AMR **5**, Rev. 1514] is applied to investigate compressor blade flutter. Existence of limit cycle, at which energy fed from flow to the blade just vanishes, is investigated under plausible assumptions of the readjustment of the instantaneous values of moment and lift at change of angle of attack. Steady-state values are represented by broken straight lines, with sudden change of slope at stall.

Experimental works are confined to determination of static and dynamic moment and lift characteristics of airfoils in cascade. Reviewer does not agree with method of extrapolating experimental frequency to "critical" frequency by assuming constant lagging time of flow separation. Effect of cascade is found to be primarily due to separation. L. S. Dzung, Switzerland

Propellers, Fans, Turbines, Pumps, etc.

(See also Revs. 921, 929, 956, 1058, 1081, 1082, 1094, 1126, 1143, 1146, 1155, 1156, 1157, 1168, 1169, 1194, 1197, 1199, 1203)

1127. **Fisch, J., The Kaplan turbine—design and trends,** *Trans. ASME* **76,** 5, 765–773, July 1954.

1128. **Stephenson, J. M., Off-design performance of gas turbine engines,** *Engineer, Lond.* **198,** 5138, 78–79, July 1954.

1129. **Hálasz, D., On the limiting vacuum** (in Hungarian), *Magyar Energiagazdaság* **6,** 1, 16–20, 2 figs., 1953.

In steam turbines a reduction of the temperature of the cooling water entails a decrease in condensator pressure and an increase of thermal efficiency and of output. This, however, is only valid up to a "limiting vacuum." Having deduced its analytical formula and controlled the latter by experiments, it was found that the limiting vacuum appeared at a time when the axial velocity of the last rotor element is $V\eta$-fold, the velocity of the flowing steam (η = efficiency of the process). The turbine output decreases from the stage of attaining the limiting vacuum to that of attaining sound velocity; a further increase of the vacuum has no bearing upon it. The effect on economy is negligible. Under certain circumstances, e. g., in the event of (a) an exhaust hood with a good diffusor efficiency, (b) turbines built for low (0.06–0.08 at abs) pressure and using cold (1–2° C) cooling water, and (c) high turbine loads, the transgression of the limiting vacuum may cause damages in the condenser. The occurrence of limiting vacuum can easily be eliminated by reducing the quantity of cooling water or the pressure of admitted steam.

Courtesy of Hungarian Technical Abstracts R. E.

1130. **Tsukakoshi, O., On a new device for evacuation in high vacuum,** *J. sci. Res. Inst. Tokyo* **47,** 133–148, Dec. 1953.

1131. **Liaskovskiĭ, I. D., Thermodynamic calculation of reciprocating air compressors, based on the theory of similitude** (in Russian), *Izv. Akad. Nauk SSSR Otd. tekn. Nauk* no. 10, 1452–1455, Oct. 1953.

A dimensionless constant P_k, being a function of $\sigma = \eta/(1 + \epsilon)$ and $\xi = P_i/P_{max}$, is calculated. The best values for P_k ($0.186 < P_k < 0.274$ for the metric units used) are established from graphs. Method allows quick assessment of over-all dimensions and power requirements of newly designed compressors and ways of improving the working of existing compressors.

A similar theory for single and multistage reciprocating steam engines has been developed previously.

O. Delatycki, Australia

1132. **Moriya, T., and Takano, A., Hydrodynamic theory of centrifugal pump or fan,** *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., 423–426, May 1952.

Paper treats the behavior of an incompressible, inviscid fluid subjected to the action of a rotary impeller of arbitrary profile. The velocity distribution over the impeller profile is obtained analytically, subject to the assumption that the fluid medium extends indefinitely in two-dimensional space.

J. F. Manildi, USA

1133. **Tahara, H., On the chief dimensions of a centrifugal pump,** *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., 427–430, May 1952.

Author develops a method of designing a centrifugal pump with spiral casing from the standpoint of maximizing the over-all efficiency of the pump. The method depends on assuming loss coefficients, and hence the accuracy is dependent upon the intelligent selection of these coefficients. No experimental data are presented. J. F. Manildi, USA

1134. **Reddy, K. R., Relative eddy and its effects on the performance of a radial bladed centrifugal impeller,** *J. roy. aero. Soc.* **58,** 524, 547–555, Aug. 1954.

The flow in a radial-bladed centrifugal impeller is treated by superposition of a radial through flow and a relative eddy flow, defined as that flow taking place in the impeller channels if peripheral dams are placed at inner and outer radii. The relative eddy flow is determined by the solution of a boundary-value prob-

lem in two-dimensional, incompressible, nonviscous flow with constant vorticity. The tangential velocity of the relative eddy flow is found at all radii. Comparison is made with Stodola's approximate theory. Experimental data are presented, showing somewhat lower work done on the fluid and lower rotor efficiency than theory predicts. Friction losses are estimated using pipe friction data. W. G. Cornell, USA

1135. Tyson, H. N., Jr., Experimental study of flow between centrifugal pump shrouds, *Hydrodynamics Lab. Calif. Inst. Technol. Rep.* no. E-19.6, 26 pp., July 1954.

An experimental investigation of the flow between the shrouds of an impeller has shown that gross flow separation can occur for "well-designed" shapes. Rotation of the shrouds inhibits separation and, if the flow coefficient is sufficiently low, it can be completely prevented.

For the particular impeller shroud profile studied, it was found that the velocity distribution in the inlet regions (near where the impeller inlet edge should be placed) is satisfactorily approximated by potential theory. Potential flow velocity distributions on several families of shroud shapes suitable for impeller or supercharger design are given for use in design.

R. C. Binder, USA

1136. Miyadzu, A., Hydrodynamics of the end clearances of a gear pump, *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., 417–421, May 1952.

Author discusses the problem of the flow of a viscous, incompressible fluid in the clearance space between the casing and the flat end of a gear pump. He develops an illustrative example. No experimental data are presented.

J. F. Manildi, USA

1137. Brajnikoff, G. B., Method and graphs for the evaluation of air-induction systems, *NACA Rep.* 1141, 22 pp., 1953.

Supersedes article reviewed in AMR **5**, Rev. 3209.

1138. Fraser, D., The characteristics of an orifice-type icing-detector probe, *Nat. aero. Establ. Canad.* LR-71, 25 pp., June 1953.

Flow and Flight Test Techniques

(See also Revs. 1091, 1112, 1122, 1217, 1231)

1139. Irmay, S., Empirical rating formulas for current meters (in French), *Houille blanche* **9**, 4, 461–465, July/Aug. 1954.

1140. Iwasaki, H., Measurements of viscosities of gases at high pressure. II. Viscosities of nitrogen and mixtures of nitrogen and hydrogen, *Sci. Rep. Res. Inst. Tôhoku Univ. Japan* (A) **6**, 3, 296–307, June 1954.

1141. Laufer, J., Factors affecting transition Reynolds numbers on models in supersonic wind tunnels, *J. aero. Sci.* **21**, 7, 497–498, July 1954.

1142. Raspet, A., and Bryant, G. D., Flight measurements of trailing-edge suction on a sailplane, *Aero. Engng. Rev.* **13**, 1, 26–36, Jan. 1954.

The investigation was conducted on a sailplane TG-3A. The wing has an NACA 4416 profile. The suction slot at the trailing edge is extended to $^3/_4$ of span. Seven different shapes can be formed by inserts. The hoods at the ends of the wings have openings which are connected with the suction slot by tunnels. In this way, a suction flow exists from the trailing-edge slot to the hood opening.

The values of lift increase, drag decrease, and rolling moment, which have been stated before by the reviewer, are not attained. Also the lift increase which has been given in the United States is not attained.

It must be determined if there is any possibility of sucking-off uniformly along the length of the suction slot used in the testing device. A rough calculation shows that this is possible only with slots smaller than $^1/_2$ in. Testing with small slots like that is not attempted, but it can be seen that a slot 2 in. wide has no effect and 1 in. has only a small effect. If small slots are selected, it is important to regain a part of the kinetic energy of the air flow of diffusers. If the drawings of the report are right, the diffuser angles shown on the small slots are too big to achieve pressure recovery.

The shape of the trailing edge is shown rounded. Compared with a sharp-edged trailing edge, it is possible that a big part of the sucked-off air came from the pressure side; that means that the expected lift-increasing suction effect cannot be attained.

The shape of the hood opening is formed on the basis of careful investigations of pressure distribution. In reviewer's opinion, the opening should be larger, but special attention has to be given that the air leaves in a direction opposite to the flight direction.

The tests do not indicate any advantage between trailing-edge suction and automatic suction for aircraft. Too optimistic expectations are certainly wrong. B. Regenscheit, Germany

1143. Fail, R. A., and Eyre, R. C. W., Downwash measurements behind a 12-ft diameter helicopter rotor in the 24-ft wind tunnel, *Aero. Res. Counc. Lond. Rep. Mem.* 2810, 12 pp., Sept. 1949, published 1954.

Some measurements of downwash have been made in a plane behind a 12-ft diam helicopter rotor over a range of shaft inclination and tip speed ratio. In the various operating conditions, the tunnel tests are in reasonable agreement with the theoretical results for the appropriate type of loading.

From authors' summary

1144. Brescia, R., Wall interference in a perforated wind tunnel (in Italian), *Atti. Accad. Sci. Torino* **87**, 1952/1953; *Monogr. sci. Aero.* **87**, no. 322, 1–20, 1953.

Author shows from two-dimensional cascade theory that gapped wall with infinitesimal chord and pitch is equivalent to a boundary where tangential velocity jump across wall is proportional to normal velocity through wall. He determines rules for the magnitude and placement of singularities to satisfy this condition when the wall is near a given singularity, and velocity field is required on the same side as well as on the opposite side of wall from the given singularity. As a specific case, he considers a singularity encompassed by two parallel gapped walls which are, in turn, encompassed by the external boundaries of a free jet. When jet boundary is allowed to coincide with gapped wall, this is called perforated wall.

Author's definition of gapped wall is identical with the perforated wall of P. Maeder [Brown Univ. TRWT-9]; author's perforated wall is a new concept. The idea of rotated images as conceived by J. Hill [*United Aircraft Rep.* R-95630-9] is virtually reproduced, as well as a solution of the reviewer for determining porosity for zero interference [*Cornell aero. Lab. Rep.* AD-594-A-3]; the work is an independent effort, however.

The utility of perforated wind tunnels as an ideal transonic testing instrument is never hinted at.

T. R. Goodman, USA

1145. **Sun, T. F., On the attenuation of a shock wave reflected from a slotted wall,** Cornell Univ. Grad. School Aero. Engng., Ithaca, N. Y., 63 pp., Aug. 1953.

The attenuation of shock waves reflecting from slotted walls is of great importance in the design of transonic wind tunnels. In this paper the structure of the flow field, produced by the interaction of reflected expansion and compression waves from streamwise slots and slats, is examined theoretically and it is concluded that, to the first order, attenuation of the compression waves should occur in the absence of frictional effects. The interaction is considered to occur by virtue of a conical flow field emanating from the edge of the slots. Lighthill's methods, by which the correct location (to the first order) of the first-order effects can be found, are used, and numerical integration is employed to determine the configuration of the attenuated compression waves in the region of interaction. Beyond a point where the compression wave is no longer of first-order strength, no solution has been found.

In an appendix, an analogous calculation is carried out for the case of diffraction of a shock wave by a right-angle edge, and the results are found to compare favorably with experiment.

H. J. Allen, USA

1146. **Sänger-Bredt, Irene, Flight towing experiments at moderate subsonic speeds of supersonic ramjets** (in German), *VDI-Forschungsheft* 437, 40–60, 1953.

Report covers German wartime tests of ramjets at subsonic speeds and gives detailed results obtained from a ramjet mounted on a Mach number $M = 0.3$–0.4 aircraft.

First part of report gives a clear discussion of separation of internal and external flow parameters and the accompanying test requirements. Tests under discussion were carried out using pressure measurements for internal flow and impulse or total head measurements for external flow, thus giving drag, thrust, and net thrust.

The next section gives details of test arrangement. Ramjet was 8.6 m long, maximum diam of 1 m, and was carried on top of a DO 217 E-2 airplane. Test flights were made at 2, 4, and 7 km altitude. Planned tests at 15 km alt, $M = 0.8$ on an Me 262 aircraft were not conducted.

Body of report gives test results. A summary of thrust measurements at stoichiometric or richer fuel flows is given and compared with theory. Discussion of errors in theory and test is given; agreement is generally good, and a thrust coefficient of 0.55 at $M = 0.35$ is obtained at an altitude of 4 km. Measurements were also carried out in throttled flow and cold flow. Form and friction drags for the internal flow are measured and compared with theory. External drags are evaluated for both hot and cold flows.

Finally, net thrust and fuel flow measurements are given; the highest net thrust coefficient is 0.45 at fuel flows about 15% above stoichiometric.

This report is well written and makes worth-while reading because of its complete testing description, although the work is now 10 years old.

B. W. Augenstein, USA

Thermodynamics

(See also Revs. 1129, 1131, 1140, 1161, 1164, 1165, 1179, 1181, 1224)

1147. **Tsvetkov, V. T., Internal combustion engines** (in Russian), Kiev and Moscow, Mashgis, 1953, 530 pp. $2.

Contents: Brief historical notes on the development of engine construction (4 pp.); Automobile and tractor carburetor engine (131 pp.); Automobile and tractor C. I. engines (87 pp.); Cooling (17 pp.); Heavy stationary and ship C. I. engines (112 pp.); High-speed engines of high output (27 pp.); Gas engines (20 pp.); Future development of heavy stationary and ship engines (3 pp.); Lubrication (16 pp.); Stressing of major engine components (68 pp.); Ignition (30 pp.).

The book is designed for engineering students specializing in this subject and deals with the reasoning leading to desirable engine layouts and detail designs. It is of a rather general nature endeavoring to cover a wide field (excluding aircraft engines). Fuel injection parameters, thermal stresses and stresses in such components as pistons, piston rings, connecting rods, camshafts, valve gear are dealt with in some detail, but the treatment of vibration problems is conspicuous by its absence. [The historical review is typical of present tendencies; a few samples: "The theoretical aspects of I. C. engine combustion were originally investigated by Russian engineers." "As known, the engine built by R. Diesel ran on kerosene—. The engine built in 1899 by 'Russian Diesel' worked very well on naphtha—. Thus it can be stated that the priority of producing a C.I. engine running on heavy fuel belongs to Russian engineers." "It is necessary to point out that the origin of two-stroke C.I. engines belongs to the 'Russian Diesel' works"; and again: "The priority of developing the first high-speed carburetor engine belongs to U. S. Kostovich (1850–1916) and not to Daimler."]

The value of the book is mainly in the general arrangement drawings of modern Russian engines. Of these, six petrol car engines, seven C.I. bus and tractor engines, twelve stationary and ship engines, and two high-speed C.I. engines are dealt with in some detail. Many incorporate Comet turbulence chambers while the two-stroke ones are copies of G.M.-71 engines. It is significant that only liquid-cooled engines are considered, while turbocharging is briefly mentioned.

[As a point of detail, all Russian engines are indicated by their type numbers, all foreign engines are dealt with without indicating their origin.]

J. L. Koffman, England

1148. **Wundheiler, A. W., Irreversible systems, entropy, and Riemann spaces,** *Proc. nat. Acad. Sci. Wash.* **40,** 9, 844–848, Sept. 1954.

Reformulation of the axioms of conventional thermodynamics. The author claims that his theory is valid for irreversible phenomena and contains Onsager's theory [*Phys. Rev.* **37,** p. 405, 1931; **38,** p. 2285, 1931]. However, Onsager has shown that irreversible thermodynamics involves a new principle (microscopic reversibility) not reducible to equilibrium thermodynamics which contains no reference to the time. Reviewer believes that Onsager's conclusion has not been refuted.

L. Tisza, USA

1149. **Bird, R. B., Hirschfelder, J. O., and Curtiss, C. F., Theoretical calculation of the equation of state and transport properties of gases and liquids,** *Trans. ASME* **76,** 7, 1011–1038, Oct. 1954.

See AMR **7,** Rev. 1937.

1150. **Masi, J. F., Survey of experimental determinations of heat capacity of ten technically important gases,** *Trans. ASME* **76,** 7, 1067–1074, Oct. 1954.

See AMR **7,** Rev. 2974.

1151. **Nelson, L. C., and Obert, E. F., Generalized *pvT* properties of gases,** *Trans. ASME* **76,** 7, 1057–1066, Oct. 1954.

See AMR **7,** Rev. 3710.

1152. Woolley, H. W., Thermodynamic functions for carbon dioxide in the ideal gas state, *J. Res. nat. Bur. Stands.* **52,** 6, 289–292, June 1954.

1153. Hall, N. A., and Ibele, W. E., The tabulation of imperfect-gas properties for air, nitrogen, and oxygen, *Trans. ASME* **76,** 7, 1039–1054, Oct. 1954.

See AMR **7,** Rev. 3336.

1154. Waldschmidt, E., A general empirical formula for saturation vapor pressure (in German), *Z. angew. Phys.* **6,** 7, 313–318, 1954.

The following simple two-parameter equation is obtained for the saturation vapor pressure p (measured in atmospheres) of liquids:

$$\log_{10} p = 6 - 6\{(T_s/T) + a[(T_s/T) - 1]\}$$

Here T_s is the absolute temperature of the boiling point at atmospheric pressure, a is another constant depending on the substance. This last parameter can be determined by putting known values of p and T into the equation, or it may be calculated on the basis of Clapeyron's equation from the latent heat at the boiling point.

The formula is shown to be useful for a larger number of elements and inorganic and organic liquids (some 50 examples are tabulated). It holds over a wide temperature range extending from the critical point to near the point of solidification. As author points out, equation cannot be expected to apply, however, to substances and in temperature ranges in which molecular associations or dissociations take place.

W. Hitschfeld, Canada

1155. Holinger, C. J., Safety disks, *Instrum. Automat.* **27,** 3, 452–454, Mar. 1954.

Users can make safety-disk pressure reliefs by proper choice of material and by constructing the disks in accordance with a few simple calculations and adequate proof tests. A complete program is presented. From author's summary

1156. Miller, B., Gas turbine process using added steam, ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-42, 5 pp.

Paper outlines the possibilities inherent in equipment now in the developmental stage designed to add steam to the air used in the gas-turbine process. The author demonstrates the improvements through steam addition by describing application of the method to the G-E one-compressor, two-turbine gas-turbine power plant. From author's summary

1157. Pfenninger, H., Operating experiences with gas-turbine plants in the steel industry—comparison of the gas turbine with other prime movers, ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-21, 13 pp.

Heat and Mass Transfer

(See also Revs. 943, 944, 1087, 1140, 1155, 1208, 1229, 1245)

1158. Price, P. H., and Slack, M. R., The effect of latent heat on numerical solutions of the heat flow equation, *Brit. J. appl. Phys.* **5,** 8, 285–287, Aug. 1954.

It is shown that the stability of numerical solutions of the heat-flow equation is unaffected by the presence of a large isothermal heat evolution.

From authors' summary by Y. L. Luke, USA

1159. Mackey, C. O., and Gay, N. R., Cooling loads from sunlit glass and wall, *Heating, Piping and Air Conditioning* 26, 8, 123–128, Aug. 1954.

Analogy methods are extremely useful when it comes to complex problems in transient heat exchange with nonlinear boundary conditions and a great number of simultaneously participating bodies.

Authors have used the hydraulic analogy to study the cooling load and heat gain from solar radiation in a room under prescribed conditions regarding heat resistance of the surfaces, heat capacity of the construction parts, the sol-air temperature and transmitted radiation through glass as a function of the hour of the day, and assuming the four cases: constant temperature of room air, steady and interrupted air conditioning, and night precooling.

Temperatures are tabulated for different parts of the room. Authors find that the peak cooling load is only a fraction of the peak instantaneous rate of heat grain.

Reviewer believes that, because of the high accuracy of the method used, the value of the results will be mainly dependent on an accurate estimation of the boundary conditions. The investigation shows how very adaptable analogy methods are to problems of the kind treated. C. E. Lenngren, Sweden

1160. Dobryshman, E. M., One particular case for the problem of heat conduction for two media (in Russian), *Prikl. Mat. Mekh.* **18,** 2, 219–224, Mar./Apr. 1954.

This is a problem in one dimension, namely, the heating of two infinite conducting media $x \leq 0$ and $x \geq 0$ when a given amount of heat is flowing to the separating plane $x = 0$. Thermal constants are functions of x, subjected to adequate physical conditions of boundedness and being developable in power series. Also the amount of heat flowing to $x = 0$ can be expanded in a series in integral powers of $t^{1/2}$ (t denotes time).

Author solves his problem by means of new independent variables and his device must be designated as a very happy idea. It would perhaps be of interest if the more profound motives leading the author to his conclusions were known, for a similar method might be applicable also to more general cases.

The reading is not difficult; nevertheless, reviewer believes that it was possible, in such a short paper, to avoid some small errors and omissions. For instance, the significance of a_n and $\lambda_0^{(i)}$ should be expressly stated at the bottom of p. 220. It also seems that, under the summation sign in the second equation (3), the factor $(-1)^n$ is omitted.

The solution follows in form of infinite series in powers of $t^{1/2}$ and is only applicable for small values of time t. The coefficients of these series are complicated functions of x and must be calculated step by step from certain recurrent relations. Author illustrates his method on a simple special case.

Reviewer likes the article under review and recommends that interested specialists examine further possibilities in this direction. Despite its importance in connection with practical purposes, theory of heat conduction for the case of variable thermal constants has not been given much study.

V. Vodička, Czechoslovakia

1161. Barrington, A. E., Phenomena associated with the disintegration of fuse wires, *Engineer, Lond.* **198,** 5141, 187–189, Aug. 1954.

By means of experiments in air, both at atmospheric and reduced pressures, and improved recording technique, modern theories as to the manner of breakup of fuse wires under short-circuit conditions are confirmed. Also, the characteristics of heavy-current arcs, following disintegration of the wires, are

discussed. Based on experimental results, a novel reduced-pressure fuse is described. From author's summary

1162. **Keyes, F. G., Thermal conductivity of gases,** *Trans. ASME* **76,** 5, 809–816, July 1954.
See AMR **7,** Rev. 1628.

1163. **Mason, H. L., Thermal conductivity of some industrial liquids from 0 to 100 C,** *Trans. ASME* **76,** 5, 817–820, July 1954.
See AMR **7,** Rev. 1269.

1164. **Dick, M. F., and McCready, D. W., The thermal conductivities of some organic liquids** *Trans. ASME* **76,** 5, 831–839, July 1954.

The thermal conductivity k of 20 liquids was determined within 2% in a Jakob horizontal layer cell at 20 and 60 C. Available published equations showed average deviations from the results averaging some 10%. Good correlation of k was obtained vs. N, the number of atoms of C or O in the longest single path through the molecule. At 60 C, $k = 0.00029 + 0.000002\ N - \Delta k$ cal/sec cm °C, where $10^6\ \Delta k = 12$ for 1 or 2 methyl side chains on a carbon, 3 for an ethyl, 6 for a butyl, and -2 for a carbonyl oxygen. C. F. Bonilla, USA

1165. **Pagerey, P. R., St. Clair, C. R., and Sibbitt, W. L., The thermal conductivity of organic liquids,** ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-55, 12 pp.

The absolute thermal conductivity of ethyl, vinyl, and butyl acetates, adiponitrile, acrylonitrile, dibutyl phthalate, methyl methacrylate, and dimethyl formamide and acetamide was measured to ±2.5% in a concentric cylinder cell at 20 to 90 C. The conductivities and their linear temperature coefficients are reported. The temperature of the inner, heated cylinder was measured by thermistors. C. F. Bonilla, USA

1166. **Hermann, R., Heat transfer by free convection from horizontal cylinders in diatomic gases,** *NACA TM* 1366, 73 pp., Nov. 1954. (Translation from *VDI Forschungsheft* no. 379, 1936.)

Report, which was originally published in 1936, presents results of comprehensive study of free-convection flows about horizontal cylinders. First part consists of correlation of existing data; heat-transfer laws for flows with small and large Grashof numbers and arbitrary temperature difference ratios are derived empirically. Second part includes solution of boundary-layer equations applicable when the Grashof number is large and the temperature difference ratio is small.

Comparison between free-convection flows over vertical plates and horizontal cylinders is made in the third part of paper; results are expressed in terms of plate length to cylinder diameter ratios for equivalent flows. Last part includes results of schlieren study to determine onset of transition from laminar to turbulent flow on plates and cylinders. G. M. Low, USA

1167. **Klein, H., Heat transfer by free convection in connection with melting of metals** (in German), *Z. Metallk.* **44,** 10, 450–456, Oct. 1953.

The rate of heat transfer by free convection in a metallic melt was calculated by applying Eckert's approximate expressions for natural convection which were formulated from Prandtl's boundary-layer concept in fluid flow. For the case of molten zinc, the heat flux at the solid-liquid interface varies according to the 5/4 power of the temperature difference. Results of computation also indicate that an understanding of the mechanism of heat transfer at the liquid-solid boundary is possible in the light of the boundary-layer theory alone. However, direct verification calls for accurate measurements of temperature profile which the author has not been able to perform.

Arguments were put forward to the effect that the problem of temperature equalization during solidification of a metallic melt could be studied with good accuracy without taking into account the influence of free convection. Author discusses the effect of change in physical and thermal properties of the melt in the neighborhood of the solidification temperature, and limitations of the application of Eckert's formulas are pointed out.
B. T. Chao, USA

1168. **Wilson, D. G., and Pope, J. A., Convective heat transfer to gas turbine blade surfaces,** *Engineer, Lond.* **198,** 5144, Aug. 1954.

1169. **Staniforth, R., A theoretical note on effusion cooled gas turbine blades,** *Aero. Res. Counc. Lond. curr. Pap.* 165, 30 pp., 19 figs., 1954.

A number of new solutions of the dynamic and thermal boundary-layer equations are presented for two-dimensional low-velocity laminar flow of a constant property fluid over semi-infinite wedges for five wedge angles between 0–180°. Heat-transfer coefficients obtained by these solutions are used to obtain approximate information on local heat-transfer coefficients around transpiration-cooled turbine blades by the postulation of equivalence of local flow and heat-transfer conditions on wedges and on the blade surface.

An empirical correlation is included to account for temperature variations throughout the boundary layer, and local heat transfer in the region of turbulent boundary layers is calculated on the assumption that transpiration cooling has no effect on heat transfer in this flow region. (More information on the influence of temperature variations throughout the boundary layer is available through calculations by B. W. Brown and co-workers, published in NACA reports. Measurements by H. S. Mickley show that heat transfer in turbulent boundary layers is decreased by ejection of air into the flow.) E. R. G. Eckert, USA

1170. **Bergelin, O. P., Brown, G. A., and Colburn, A. P., Heat transfer and fluid friction during flow across banks of tubes—V. A study of a cylindrical baffled exchanger without internal leakage,** *Trans. ASME* **76,** 5, 841–849, July 1954.
See AMR **7,** Rev. 1953.

1171. **Zhukhovitskiĭ, E. M., Stability of fluid at rest in a temperature gradient, according to method of Galerkin** (in Russian), *Prikl. Mat. Mekh.* **18,** 2, 205–211, Mar./Apr. 1954.

Fluid is supposed to be contained in a hollow of a solid which participates in conducting heat, as supplied from below. In the critical range where conduction gives way to free convection, the steady distributions of pressure, density, and temperature are determined by three simultaneous linear homogeneous differential equations. By expanding their solutions in series of polynomials, the critical gradient of temperature is expressed as an eigenvalue of a matrix, the order of which increases with the accuracy required. Author shows that a 2×2 matrix yields a good approximation in the case of a vertical cylinder where the exact solution is known. The method is applied to a horizontal cylindrical container. Calculated results are shown in diagrams; there is no comparison with experiment. R. Eisenschitz, England

1172. Drakhlin, E. Kh., Convection in an infinite horizontal elliptic cylinder (in Russian), *Prikl. Mat. Mekh.* **18**, 2, 215–218, Mar./Apr. 1954.

Author considers horizontal cylinder filled with viscous liquid and embedded in infinitely extended solid. The combined two-dimensional problem of heat conduction, within the solid, and of free convection, within the liquid, is solved approximately by assuming that the temperature gradient within the solid is constant at infinity. The solution is cumbersome.

A. von Baranoff, France

1173. Parolini, G., Emissivity measurements for aluminum surfaces with various treatments (in Italian), *Termotecnica* **8**, 2, 151–165, Feb. 1954.

Author describes method and results of tests on emission of radiant energy from variously coated aluminum surfaces. Report is prefaced by definitions and review of theory. Author derives expressions for "normal emissivity" factor and ratio of "total hemispherical emissivity" to normal emissivity. A discussion is included of method used and results obtained by previous investigators. Data were obtained by measuring surfaces under test and repeating tests with a black body at the same test temperature. Thus, ratio values were obtained. Data given are for painted and degreased aluminum surfaces. Subsequent report will cover oxidized aluminum surfaces. Color of paint has an appreciable effect on emissivity. Maximum emissivity was obtained with transparent paint. Derived formulas permit sufficiently accurate calculations of emissivity and total radiation from painted or unpainted aluminum surfaces, based on the method and the materials used by the author.

Data permit selection of paint and particularly the base that will give maximum emissivity.

Author is commended for the thorough manner in which he has presented the subject matter of the paper.

M. Martellotti, USA

1174. Liepmann, H. W., and Skinner, G. T., Shearing-stress measurements by use of a heated element, *NACA TN* 3268, 27 pp., Nov. 1954.

The fundamental diffusion process governing heat and vorticity transfer from a flow boundary is employed to relate skin friction and heat-transfer rate. A "hot-wire" embedded in an insulated surface thereby provides a measurement technique for local skin friction. Pressure gradients are permissible, and extension to the compressible case appears promising. For the turbulent case, the restriction to thermal layers lying within the laminar sublayer implies that a single calibration should suffice for both laminar and turbulent layers. Experimental data are presented as confirmation. J. R. Baron, USA

1175. Katz, S., and Peiser, A. M., A system of non-linear partial differential equations arising in heat transfer, *J. Math. Phys.* **32**, 4, 256–268, Jan. 1954.

Paper considers equations describing transfer of heat or of mass from a fluid to a bed of particles through which the fluids flow. In certain ranges of temperature or mass concentration, parameters dependent on physical properties of materials may be assumed constant. Here equations are linear and solution is known. [See S. Goldstein, "On the mathematics of exchange processes in fixed columns. I. Mathematical solutions and asymptotic expansions. II. The equilibrium theory as the limit of the kinetic theory," *Proc. roy. Soc. Lond.* (*A*) **219**, 151–171 and 171–185, respectively, 1953.] If assumption is not valid, solution is accomplished using finite difference techniques. Paper studies existence, uniqueness, and convergence of finite difference solution.

Y. L. Luke, USA

1176. Albertson, M. L., Extension of Reynolds' analogy to evaporation (in French), *C. R. Acad. Sci. Paris* **239**, 6, 474–476, Aug. 1954.

For the relation between nondimensional evaporation coefficient and skin-friction coefficient in turbulent flow, author assumes an analogous expression to von Kármán's formula [*Trans. ASME* **61**, 706–710, 1939], which expresses the relation between heat-transfer coefficient and skin-friction coefficient. Wind-tunnel experiments concerning the evaporation of water from a saturated plane surface are in good agreement with author's formula. H. Tamaki, Japan

1177. Palladino, N. J., The thermal design of nuclear power reactors, ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-58, 15 pp., 1 fig.

Paper includes derivation of the more important heat-transfer and fluid-flow relationships which govern the optimization of the large number of independent variables involved in the thermal design of water-cooled power reactors. Paper implies, and reviewer concurs, that analyses of this type involve such a large number of specific relationships and assumptions that results are not particularly general, even for water-cooled power reactors. Reviewer also feels that the close interplay required between the thermal analysis and the reactor physics and design could have received stronger emphasis in the course of the analysis. Despite these minor shortcomings, reviewer feels author has made a good presentation of one type of analysis required in reactor design.

R. L. Mela, USA

1178. Armacost, W. H., The controlled-circulation boiler, *Trans. ASME* **76**, 5, 715–724, July 1954.

See AMR **7**, Rev. 2628.

1179. Brown, G., Theory of moist air heat exchangers, *Kungl. tekn. Högskol. Handl.* no. 77, 32 pp., 1954.

Method is presented for design of air coolers and heaters with and without moisture on surfaces. Both plain and extended surfaces are treated. Driving force is expressed as enthalpy difference. Basic assumptions are negligible mass transfer and that film coefficient of heat transfer is unaffected by moisture on surface. A fin efficiency for moist surface is defined and shown to be lower than fin efficiency for dry exchangers. Examples show calculation of surface temperature in cooler with wetted surface, calculation of surface area, and design of cooler in which surface is partly dry. O. P. Bergelin, USA

1180. Braddon, G., Part 1, Waitkus, J., Part 2, Design and operation of high-recovery regenerative-type air preheaters. 1. Special features of the regenerative-type air preheaters. 2. Operation of high-recovery regenerative-type air preheaters, *Trans. ASME* **76**, 5, 697–712, July 1954.

Combustion

1181. Gaydon, A. G., and Wolfhard, H. G., Flames—their structure, radiation and temperature, London, Chapman & Hall Ltd., 1953, xii + 340 pp. 55s.

This is a treatise on the stationary flame, an important part of the combustion field, by authors who have contributed significantly to research on the subject. Interest is in laboratory flames rather than industrial, and emphasis is placed more on the physical than on the chemical processes involved. Presentation is

mainly descriptive, with mathematics introduced only where indispensable to the argument. Historical reviews of experimental and theoretical work are given where they are important to understanding the present state of knowledge. Experimental techniques in flame research are discussed and evaluated in sufficient detail to be very valuable for less experienced workers in the field.

Specific subjects treated include flow patterns and shapes of premixed and diffusion flames, burning velocity measurements, flame propagation, and flame instability. The origin and nature of radiation from flames and flame-borne solid particles are discussed in two chapters. Three chapters are devoted to methods of measuring and calculating flame temperatures and one to ionization in flames. Finally, outstanding problems in flame research are indicated. This should prove a valuable addition to the library of any worker in the combustion field.

W. P. Jensen, USA

1182. Townsend, D. T. A., Highways and by-ways in combustion (the Melchett lecture for 1952), *J. Inst. Fuel* **27,** 166, 534–544, 571, 4 plates, Nov. 1954.

1183. Hicks, B. L., Theory of ignition considered as a thermal reaction, *J. Chem. Phys.* **22,** 3, 414–429, Mar. 1954.

Paper discusses the numerical solution of the time-dependent one-dimensional heat-conduction equation with a heat source term, for a semi-infinite slab. The heat source term is of the simple exponential Arrhenius type for a zero-order reaction. The novel feature of this discussion appears in the specification of the boundary condition. It is supposed that the external temperature changes suddenly from one constant value to another much lower value, at the end of a certain specified interval of time (the "heating time").

The "ignition time" (defined as the time required for the surface to attain a specified temperature, the "ignition temperature") is a minimum when the heating time is extended until ignition occurs. The time for ignition is quite sensitive to the heating time when the latter value is chosen close to the minimum ignition time. The discussion aims at presenting the ignition time as a function of external heating rate intensity and duration, and of the initial temperature of the solid for a given choice of the ignition temperature.

Reviewer believes the paper to be an interesting mathematical exercise but of highly doubtful applicability to real propellants. First, there has been little, if any, evidence which points to any clear and unique value for the so-called ignition temperature. Second, the concept of the "adiabatic ignition time," as introduced by the author, is a deficiency of the model and should be quite irrelevant to the discussion of normally stable propellants. Third, the chemical kinetics of the reaction cannot be safely disregarded for the sake of expediency and merely replaced by the assumption of a zero-order reaction. And finally, if the theory of flame propagation serves as any guide, it may be expected that the mechanism of diffusion (particularly of free radicals) will play as important a role as thermal conductivity in the phenomenon of ignition. M. Mitchner, USA

1184. Arnold, J. S., and Sherburne, R. K., Observations of the ignition and incipient flame growth in hydrocarbon-air mixtures, Fourth Symp. (International) on Combustion, 139–143, 1953; Baltimore, Md., Williams & Wilkins.

Combustible mixtures flowing from cylindrical burners were ignited by electric sparks with "minimum ignition energies." The incipient flame was self-propagating in approximately one half of the experiments. From schlieren photographs the flame growth is plotted as a function of time. A comparison of flame kernels that grow to the stream boundaries with those that fail shows little difference in rate of growth for approximately 200 microsec; but, after this interval, flames that complete ignition exhibit a more rapid increase in size. The "critical radius" of a combustion bubble, above which it grows and below which it does not, depends on the fuel and mixture ratio. Mixtures with the smallest critical radii require the least ignition energies.

For the hydrocarbons investigated, namely methane, ethane, butane, and propane, the minimum critical radii correspond to the mixtures in which the number of hydrogen atoms is equal to the number of oxygen atoms. No similar correlation is found by the authors for any other combination of the constituent atoms. J. Manton, USA

1185. Olsen, H. L., Gayhart, E. L., and Edmonson, R. B., Propagation of incipient spark-ignited flames in hydrogen-air and propane-air mixtures, Fourth Symp. (International) on Combustion, 144–148, 1953; Baltimore, Md., Williams & Wilkins.

Experimental observations are reported for spark-ignited flames propagating at constant pressure near the ignition source. Very interesting schlieren photographs show irregularities in the flame shape that resemble cellular structure, especially for lean hydrogen mixtures. Authors explain this phenomenon as burning in the turbulent wake of the electrodes. The transformation velocity that is determined as a function of time from measurements of the photographs is observed to alter its value with time. For a lean hydrogen-air flame the transformation velocity decreases from a high value to its expected steady-state value; whereas, for an approximately stoichiometric propane-air mixture, the transformation velocity decreases from a high value to one considerably below the expected steady-state value. According to the authors, the transformation velocity in a propane-air flame passes through a minimum value in the spark-ignition process.

J. Manton, USA

1186. Popov, V. A., Certain laws of the predetonation stage of flame propagation (in Russian), *Izv. Akad. Nauk SSSR Otd. tekn. Nauk* no. 10, 1428–1439, 1 plate, Oct. 1953.

1187. Worrall, G. I., Measuring burning quality of distillate fuels, *Indust. Engng. Chem.* **46,** 10, 2178–2182, Oct. 1954.

1188. Egerton, A. C., and Badami, G. N., An adjustable flat flame burner, *Fuel* **33, 4,** 406–408, Oct. 1954.

A flat flame burner is described with which the position of the matrix and of the gauze can be adjusted in relation to the lip of the burner. The burner can be used for precision measurement of the burning velocity of slow flames.

From authors' summary

1189. Coffin, K. P., Burning times of magnesium ribbons in various atmospheres, *NACA TN* 3332, 37 pp., Dec. 1954.

1190. Garner, F. H., Long, R., and Thorley, B., Measurement of the burning velocities of hydrocarbon-air mixtures using a nozzle burner, *Fuel* **33,** 4, 394–405, Oct. 1954.

A study has been made of the nozzle-burner method of measuring burning velocities using benzene-air, propane-air, and ethylene-air mixtures. Luminous, shadow, and schlieren images of the flame cones have been measured. The luminous and schlieren images were found to be almost parallel over the major part of the nozzle flame cone. While burning velocities deduced from the schlieren cone by angle- or frustrum-area methods vary with the

rate of flow of the unburnt gas, those obtained by the total-area method are independent of the flow rate. However, when corrected for temperature, the burning velocities obtained by the latter method are low, as would be expected.

From authors' summary

1191. Strehlow, R. A., and Stuart, J. G., An improved soap bubble method of measuring flame velocities, Fourth Symp. (International) on Combustion, 329–336, 1953; Baltimore, Md., Williams & Wilkins.

Burning velocities at atmospheric pressure are reported for ethylene air mixtures from 5 to 9.5%. Alternative procedures were considered for the calculation of burning velocity, but only the treatment of Stevens was sufficiently accurate in application. A nonaqueous detergent in glycerin was used for bubbles blown in a closed atmosphere of argon to prevent afterburning. Schlieren records of flame growth with timing marks from an oscillator were measured with a comparator for graphical construction of maximum flame diameter. Diffusion through bubbles was shown to be negligible. Experimental results for ethylene are in good agreement with other workers using bubble method. Consistency is least satisfactory for rich mixtures, due probably to cellular flame structure. Some measurements have been made with H_2–N_2O mixtures and have shown strong vibrations that may prove limiting in applying the method to fast-burning mixtures (say V_b greater than 100 cm/sec).

N. P. W. Moore, England

1192. Golitzine, N., Flame stabilization in a hot gas stream by the upstream air blast injection of kerosene fuel, *Nat. aero. Establ. Canad.* LR-102, 9 pp., 8 figs., May 1954.

The report describes experiments made in connection with the thrust boosting of jet engines by exhaust reheat, to determine the flame stability limits of kerosene fuel injected upstream into a hot gas stream by means of an air blast.

The effect on the flame stability limits of the hot gas velocity, pressure, and temperature, and the air blast pressure and flow, was determined, with a view to using this type of flame stabilization in the exhaust reheating of jet engines in flight at high altitude. The conclusion was that the flame stability limits were narrowed by increase in gas velocity and decrease in gas pressure, not greatly affected by gas temperature, and widened by increase in air blast pressure and flow. From author's summary

1193. Golitzine, N., Flame stabilization in a fast air stream by the upstream air blast injection of kerosene fuel, *Nat. aero. Establ. Canad.* LR-86, 10 pp., Dec. 1953.

Flames were stabilized in air streams of up to 200 fps by an upstream directed air blast of kerosene. No baffle stabilizers were used. Liquid kerosene was injected through an $^1/_8$-in.-OD tube projecting through the blast air orifice. Ranges of variables were: orifice sizes, $^5/_{32}$ to $^1/_4$-in. diam; blast air pressure, 2 to 90 psi; fuel flow, 7 to 15 lbs/hr; and blast air temperatures, 20 to 440 C. Correlation of results indicates an optimum blast air-fuel ratio of about 3. Maximum blowout velocity increases with increasing fuel rates.

The effect of blast air temperature is not clear and, in any event, is not large (about 10% max.).

Over-all air/fuel ratios ranged between 300 and 1000. The air-blast stabilized flame was used as a pilot flame to ignite an unspecified rate of kerosene injected further downstream.

Reviewer believes results may be optimistic, since air-blast injection was made 5 inches downstream from end of the 5-in. diam air supply duct. Burning in such an "open" system usually is much more stable than in "closed" systems (closely surrounded by walls), where burning may magnify any fluctuations in operating conditions.

An auxiliary source of pressure air may be necessary, since about 20-psi blast air pressure was required to stabilize flame in a 200-fps air stream. E. E. Frost, USA

1194. Richardson, E. G., Mechanism of the disruption of liquid jets, *Appl. sci. Res.* (*A*) **4,** 5/6, 374–380, 1954, 3 figs., 9 refs.

Photographs of a water jet issuing from a straight nozzle are obtained with microflash illumination, at varying flow velocities. Three regimes of flow can be distinguished, each of which results in a special type of breakup into drops. At the lowest velocity, first investigated by Rayleigh, capillary ripples develop on the liquid surface, causing the cylindrical surface to become "varicose," resulting ultimately in breaking up of the jet into discrete drops. At higher velocity, a sinuous oscillation ("waggling") of the cylinder axis sets in, like the thongs of a whip. At still higher speeds the friction of the air along the periphery of the jet causes the piecemeal disintegration of the jet, aided probably by turbulence within the nozzle. The second and third stages are discussed, referring to Weber's formula for the air friction of the jet, to Prandtl's boundary-layer parameter, and to the pertinent work of Lane, Merrington, and Hinze.

K. J. DeJuhasz, Germany

1195. Sviridov, Yu. B., Characteristics of turbulent burning (in Russian), *Izv. Akad. Nauk SSSR Otd. tekn. Nauk* no. 11, 1577–1597, Nov. 1953.

Author considers the division of turbulent combustion into two classes (large- and small-scale) correct but inadequate. He introduces further division into: (a) Stationary and nonstationary turbulent combustion. (b) Nonstationary combustion with an ignition source from a point and nonstationary combustion with a developed preliminary flame front. (c) Combustion with nonisotropic turbulence and isotropic turbulence.

He gives a theoretical analysis of the different kinds of turbulent combustion. A general differential equation of turbulent flame propagation is evolved. O. Delatycki, Australia

1196. Gibbons, L. C., Barnett, H. C., and Gerstein, M., Effect of molecular structure on combustion behavior, *Indust. Engng. Chem.* **46,** 10, 2150–2159, Oct. 1954.

A survey of investigations of the effect of fuel molecular structure on combustion parameters is presented in this paper. These parameters presumably play a significant role in the continuous combustion process that occurs in a gas turbine combustor. Data are presented to show the effect of the molecular structure of hydrocarbons and oxygen-containing organic compounds on minimum ignition energy, spontaneous ignition temperature, limits of flammability, flame velocity, and smoke formation. The relationship of these fundamental combustion parameters to gas turbine combustor performance is shown. From authors' summary

1197. Olson, W. J., Childs, J. H., and Jonash, E. R., The combustion-efficiency problem of the turbojet at high altitude, ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-24, 20 pp.

Paper presents research data to describe problem of combustion efficiency at high altitude. Control of inlet air pressure, temperature, and flow rate on many different combustors yielded trends which could be verified with full-scale engine operation under simulated conditions.

Paper is divided into discussion of operating variables, design variables, and fuel variables.

Numerous curves presented show (a) there must be a low velocity zone for fuel-air ratio near stoichiometric; (b) efficiency decreases with increasing altitude and decreasing engine speed; (c) efficiency approaches 100% for high values of inlet pressure and temperature; (d) efficiency decreases at accelerating rate as reference velocity increases and pressure and temperature decrease; (e) most volatile fuel yields the highest combustion efficiency.

Paper concludes that: (1) In an environment of low temperature and/or pressure, low combustion efficiencies and limiting temperature rise result. (2) Stable operation and high combustion efficiency require localized mixture near stoichiometric condition, existing long enough for ignition and combustion and thus consuming all fuel. (3) Necessary to match combustor design, fuel nozzles, and fuel. (4) Much work remains to be done. F. I. Given, USA

1198. Staab, F., On propulsive devices operating on the principle of the V-1 (Schmidt tube) (in German), *Z. Flugwiss.* **2,** 6, 129–141, June 1954.

Author describes German research during the years 1941–1944 in regard to pulsating jet motors, more commonly known as the V-1. The paper also includes a survey of the pertinent development work during the years 1937–1940 in Germany and the years 1945–1952 in the United States and in France. Wind-tunnel studies for the determination of thrust, drag, and fuel consumption are discussed, and the effects of wind velocity and altitude on these variables are considered. The paper also covers some constructional details and procedures of operation.

Combustion and flame studies are described on the basis of flame photographs obtained with a drum-type camera. With these photographs are given synchronized pressure-time oscillograms obtained with a piezoelectric pickup. It is stated the flame velocities of up to 100 mps (329 fps) were obtained and that the combustion pressure was about 0.6 atmos above atmospheric. Photographs resemble those commonly obtained in rocket-motor instability studies. A. B. Cambel, USA

1199. Barnard, D. P., and Eltinge, L., Aircraft turbine fuel properties affecting combustor carbon, *Indust. Engng. Chem.* **46,** 10, 2160–2163, Oct. 1954.

1200. Pouchot, W. D., and Hamm, J. R., Characteristics of a vaporizing combustor for aviation gas turbines, *Trans. ASME* **76,** 5, 801–806, July 1954.

See AMR **7,** Rev. 1979.

1201. Reynst, F. H., Pulsating combustion: Can we use cyclone furnace, air-turbine cycle? *Power* **98,** 11, 88–92, 214, 216, Nov. 1954.

1202. Bauserman, G. W., Prien, C. H., and Zandstra, T., Determination of transient flame temperatures, *Rev. sci. Instrum.* **25,** 7, 640–643, July 1954.

A description is given of an instrument to determine the temperatures of rapidly varying flames. This instrument uses a photoelectric modification of the line reversal method, wherein the light beam from a temperature-variable incandescent source is split into two monochromatic beams by means of mirrors and filters to impinge upon 931A multiplier phototubes. The phototube signals are sent to a mu-bridge null detector, whose output is fed to an oscilloscope for photography of results. The instrument can detect 25 K temperature differences between about 1540 and 3100 K and three millisecond time differences. Typical time-temperature results are given, along with the analytical procedures used. From authors' summary

1203. Bahn, G. S., and Koffer, G. W., Problems in formulation of design procedures for continuous-flow combustion of hydrocarbons, ASME Semi-Ann. Meet., Pittsburgh, Pa., June 1954. Pap. 54—SA-22, 15 pp.

Acoustics

1204. Skudrzyk, E., Foundations of acoustics [Die Grundlagen der Akustik], Wien, Springer-Verlag, 1954, xxii + 1084 pp., 450 figs. $35.

This monumental work is much too modestly described as foundations of acoustics. It is, in fact, a complete and up-to-date treatise, covering the whole field of acoustics and ultrasonics, with emphasis on the theoretical aspects. There is indeed no part of physical acoustics which is not dealt with and, in addition, chapters are devoted to hearing and to musical acoustics. Each section terminates with a bibliography, and the complete book has a copious subject index and list of the symbols currently employed.

Beside the subjects conventionally—though often less thoroughly—treated in handbooks of this type, the following less usual subjects are included: Wave equations in cylindrical coordinates, applications of Huyghens' principle to sound, scattering radiation from arrays of sources, coupled systems, and coupled vibrations; theory of noise; thermal damping effects; underwater propagation; waves of large amplitude.

The treatment is predominantly mathematical and the analysis is clearly set out with frequent reference to analogous problems in other branches of physics, such as one would expect from a writer of the experience which Prof. Skudrzyk brings in both research and teaching. Book is to be highly recommended.

E. G. Richardson, England

1205. Biagi, F., and Cook, R. K., Acoustic impedance of a right circular cylindrical enclosure, *J. acoust. Soc. Amer.* **26,** 4, 506–509, July 1954.

Fourier-Bessel series are derived for gas temperature T inside enclosure. Spacial average of T leads to correction curve A which accounts for effect of isothermal cylinder walls on acoustic impedance. Application of A to calibration of pressure response of condenser microphones is discussed. H. D. Block, USA

1206. Gerjuoy, E., and Saxon, D. S., Variational principles for the acoustic field, *Phys. Rev.* (2) **94,** 6, 1445–1458, June 1954.

Integral equations are obtained for the pressure and particle velocity in a medium whose density and sound velocity are finite, nonvanishing functions of position. From these expressions the scattering amplitude is obtained and related to the scattering matrix. Variational methods are developed for the scattering matrix in the case of an arbitrary spatial dependence of the density and sound velocity and for the phase shifts for the case of spherically symmetric spatial variation. R. D. Spence, USA

1207. Levine, H., On the theory of sound reflection in an open-ended cylindrical tube, *J. acoust. Soc. Amer.* **26,** 2, 200–211, Mar. 1954.

Two approximation methods are developed for the derivation of the reflection coefficient and end correction for the case of dominant mode propagation in a semi-infinite tube of arbitrary cross section. The first method is a variational procedure; the second is a function theoretic, Wiener-Hopf method which reduces to the exact result for a circular cross section. The lower bound obtained by the second method is identical with the zeroth-

order approximation of the variational procedure (i.e., for a trial function corresponding to a reflection coefficient of minus one). The results for the end correction may be used for calculations once the cross section is stated.

This paper represents the most complete and most rigorous treatment of this problem to date. V. Twersky, USA

1208. Raushenbakh, B. V., On a remark by Rayleigh concerning thermal excitation of sounds (in Russian), *Doklady Akad. Nauk SSSR (N.S.)* **91,** 4, 749–752, Aug. 1953.

Author considers neutral oscillations, neither increasing nor decreasing in amplitude, of a gaseous system containing an interface where heat is released. For neutral oscillations, pressure is 90° out of phase with velocity on either side of the interface. He assumes small amplitude linear oscillations and isentropic transfer of gas across the interface, and writes the following general equations

$$\mathbf{p}_2 = a_{11}\mathbf{p}_1 + a_{12}\mathbf{v}_1 + a_{13}\mathbf{q}$$
$$\mathbf{v}_2 = a_{21}\mathbf{p}_1 + a_{22}\mathbf{v}_1 + a_{23}\mathbf{q}$$

where 1 and 2 refer to before and after heating, respectively, a_{ij} are constants which depend on the parameters of the system, $\mathbf{p}$ is oscillating pressure, $\mathbf{v}$ is oscillating velocity, and $\mathbf{q}$ is oscillating heat release.

The dot products $\mathbf{p}_1 \cdot \mathbf{v}_1$ and $\mathbf{p}_2 \cdot \mathbf{v}_2$ are both zero. Thus, taking $\mathbf{p}_1$ as the x-axis and $\mathbf{q}_1$ as the y-axis, the scalar product of the above equations becomes

$$Ap_1q_x + Bv_1q_y + C(q_x^2 + q_y^2) + Dp^2_1 + Ev^2_1 = 0$$

The values of $\mathbf{q}$ for neutral oscillations are on a circle with radius and position of center determined by p_1 and v_1.

For a system generating Rijke gauze tones, $B/C \geq 0$, $A/C \leq 0$, and $(D/C)p^2_1 + (E/C)v^2_1 \geq 0$; neutral oscillations are impossible only with heat addition in the second quadrant. A neutral oscillation is possible with heat addition in the third quadrant; this apparently conflicts with Rayleigh's hypothesis that heat must be added in phase with the pressure to produce driving. When the mean rate of flow is zero, the equation agrees with Rayleigh's hypothesis. For a mean rate of flow greater than zero, neglect of kinetic energy by Rayleigh is indicated as the cause of the discrepancy.

If $\mathbf{q}$ becomes sufficiently large, the phase between the $\mathbf{p}_2 - \mathbf{v}_2$ system and the $\mathbf{p}_1 - \mathbf{v}_1$ system shifts to such an extent that no $\mathbf{q}$ exists giving neutral oscillations. (Reviewers note: Author has not proved that Rayleigh's hypothesis is not sufficient by itself, providing the heat energy is properly partitioned between the two sides of the interface.) W. R. Dennis, USA

1209. Bouyoucos, J. V., and Nyborg, W. L., Oscillations of the jet in a jet-edge system. II, *J. acoust. Soc. Amer.* **26,** 4, 511–514, July 1954.

Authors describe an experiment, using low-velocity jets of dyed liquids, for obtaining the history of the jet oscillation. Comparison is made with the predictions of a theory proposed by one of the authors [AMR **7,** Rev. 4070]. Photographs indicate that there is reasonable agreement, remembering that the theoretical predictions apply only to particles emanating from the orifice center, while the experiment shows the entire stream.

G. Power, England

1210. Parthasarathy, S., and Pancholy, M., Ultrasonic absorption constant in liquids by an improved optical method, *Z. Phys.* **138,** 5, 635–639, 1954.

Ultrasonic absorption in several liquids is measured in the frequency range of 4 to 15 Mc/sec using the Debye-Sears optical diffraction effect. The improved method uses two parallel beams of light, and the resulting optical diffraction patterns are focused on a common photographic plate. F. E. Borgnis, USA

1211. Hahn, R. S., On the theory of regenerative chatter in precision-grinding operations, *Trans. ASME* **76,** 4, 593–597, May 1954.

By considering a grinding wheel to be mounted on an elastic structure and by making the simple proposition that the instantaneous depth of penetration of the wheel into the work is proportional to the instantaneous dynamic force existing between wheel and work, there results a theory capable of explaining the frequently observed phenomenon of chatter. The theory predicts a spectrum of values of cycles of vibration per revolution of work for which stability should exist. Qualitatively, the theory appears to agree with practice. C. Zwikker, Holland

1212. Stevens, K. N., A survey of background and aircraft noise in communities near airports, *NACA TN* 3379, 36 pp., Dec. 1954.

1213. Beaujard, L., and Husarek, V., Some applications of acoustic rail testing with ultrasoniscopes (in French), *Rev. Métall.* **51,** 8, 558–568, Aug. 1954.

Ballistics, Detonics (Explosions)

1214. De Brun, J., Calculation of moderators with constant filling channel area. Influence of moderator on calculation of recoil channel area (in French), *Mém. Artill. fr.* **28,** 2, 255–264, 1954.

In recoil systems with a moderator to diminish the return velocity after recoil, it is necessary to fill the moderator completely during recoil. Formulas are given for the channel area and for the influence on the calculation of the recoil channel area.

J. Corner, England

1215. Darpas, M., Movement of a projectile around its center of gravity (in French), *Mém. Artill. fr.* **27,** 4, 857–946, 1953.

Author discusses motions of spinning projectiles, fin-stabilized projectiles, and rockets.

A great interest has developed during the past ten years in the movement of a projectile about its center of gravity. Such movement has an essential effect on range (time of flight) and distribution. Yaw, owing to resistance of air, can be converted into an imaginary decrease of muzzle velocity. In this matter, results obtained in France are described.

Author analyzes causes for oscillations of projectile in proximity of muzzle and shows that they essentially can be related to oscillatory motion of projectile in tube, lack of agreement between rotation and symmetry axis of the projectile, and eccentricity of center of gravity.

Work is from lectures by author on exterior ballistics. He bases his description to a great extent on the now classic work of Fowler, Gallop, Lock, and Richmond. That of Nielsen and Synge has, on the other hand, not been applied. To the person who wants a clear and easily comprehensible description of projectile motion about center of gravity, this article is recommended.

A. Silfverhielm, Sweden

1216. Engdahl, G. V., Local control sights of antiaircraft guns (in Swedish), *Artill. Tidskr.* **83,** 4, 117–127, 1954.

Two different methods of designing the mathematics of the

sights are compared: (1) course, speed, and possibly range of target are estimated, e.g., grid sights; (2) angular velocities of the gun are used together with measured or estimated range to target, e.g., gyro sights. Through differentiation of the various equations of these methods, and by using probable errors of estimation or measuring the necessary values, author makes a relative comparison.

The conclusions are: (1) Machine-aimed guns, where local control is the principal aiming method, should have theoretically "exact" predictors and radar at least for range finding; (2) where such an equipment is too expensive, e.g., when the local control is only a reserve, sights based on estimated values of target course and speed, and possibly range, should be used. As to machine-aimed guns, the basis of estimation may be taken from the angular velocities of the gun.

From author's summary by R. Sjöberg, Sweden

1217. **Dath, J., Application of short explosion photography in ballistics** (in French), *Explosifs* no. 3, 94–106, July/Sept. 1954.

Soil Mechanics, Seepage

(See also Rev. 949)

1218. **Kézdi, A., Soil mechanics [Talajmechanika], 2 vols.,** Budapest, Tankönyvkiadó, 1952, 1954, 560 pp., 467 pp., 12 plates.

The first 274 pages of vol. I deal with the physical properties of soils and their experimental determination. Basic definitions, structure, chemical properties, classification, permeability, compressibility, and shearing resistance of soils are dealt with. The rest of the first volume deals with theoretical soil mechanics—plastic equilibrium, earth pressures, arching, stability of slopes, stress distribution, bearing capacity, and consolidation.

The second volume deals with practical applications—subsurface exploration, laboratory investigations, foundation design, seepage, uplift and drainage problems, stabilization of soils, road construction, and effects of vibrations.

Both volumes are well illustrated—543 figures in vol. I and 439 figures in vol. II. The second volume has an index with references both to eastern and western technical publications in the field. G. P. Tschebotarioff, USA

1219. **Koehne, W., Determination of underground water flow and its significance in the operation of water supply works [Die Ermittlung der Wasserführung von Grundwasserströmen und ihre Bedeutung für den Betrieb von Wasserwerken],** Bielefeld, Kirschbaum Verlag, 1953, 38 pp., 19 figs. 9.50 DM.

Underground water, a limited natural resource, is to be controlled carefully. Long-period determination of the ground water yield from an exactly limited area, obtained with a large number of observation wells, gives the relative annual underground runoff. An increase in the annual precipitation height is accompanied by an equal increment of underground runoff. An example for the water works of the Magdeburg area is presented with complete numerical values. More extensive study is to be found in the author's book "Grundwasserkunde," 2nd ed., 1948. S. Kolupaila, USA

1220. **Polubarinova-Kochina, P. Ya., Theory of the movement of ground waters [Teoriya dvizheniya gruntovych vod],** Moscow, Gosud. Izdat. Tekh.-Teor. Lit., 1952, 676 pp.

This well-written and voluminous book is based on the author's lectures at Russian high schools. It is intended as a textbook for students of Russian universities and contains two main parts: the first 540 pages are devoted to stationary problems, the remainder to unsteady movement of ground water. The wide scope and variety of problems covered in the book will be clear from the titles of separate chapters.

The first main part contains the following eleven chapters, divided into 162 sections: 1. Physical and mathematical foundation of the theory of groundwater movement; 2. Plane movements in a vertical plane; 3. The pressure filtration below hydrotechnical structures; 4. Joukowski function and its use. Application of functional analysis (viz. to problems of filtration); 5. Use of circular inversion; 6. The mixed problem of the theory of functions and its application in the study of filtration; 7. Use of analytic theory of linear differential equations; 8. Filtration in nonhomogeneous and anisotropic grounds. Filtration of two liquids; 9. Springs and bores. Horizontal drainages. (The last four paragraphs of this chapter deal with some three-dimensional problems of filtration); 10. Hydraulic theory of steady movements; 11. Graphical, numerical, and experimental methods for the study of ground-water movement.

The five chapters of the second main part—41 sections—cover nonstationary problems; 12. Inertial members of unsteady movements; 13. Nonlinear equations of unsteady movements with a free surface; 14. Linear equations of the unsteady movement of groundwater (here again some three-dimensional problems); 15. Plane unsteady movements of ground waters; 16. Approximate numerical and graphical methods for the study of unsteady problems.

The book closes with a very extensive index of literature (Russian and also some non-Russian) compiled separately for each chapter, followed by a detailed index of subjects treated.

Reviewer believes each page of this work shows the great expertness of its author as well as the excellent role of Russian science in developing and applying mathematical theories to the study of ground-water movements. In spite of its expressly theoretical character, with its systematic use even of the most recent and often rather difficult mathematical expedients, the book gives sufficient emphasis to practical problems. Also welcome is the fact that all mathematical expedients are derived or, at all events, sufficiently explained immediately before the pertinent technical problem.

This successful work will probably be translated into other languages. Reviewer warmly recommends this volume, not only to interested specialists but also to physicists and mathematicians applying their science to advanced problems of engineering. V. Vodička, Czechoslovakia

1221. **Matsuo, S., Characteristics of consistency of soil shown in plasticity chart,** *Proc. 1st Japan nat. Congr. appl. Mech.* 1951; Nat. Committee for Theor. appl. Mech., 267–270, May 1952.

Experiments to study the effect of cation exchange on the consistency of three Japanese soils are described. Some of the results appear to be misleading when compared with H. F. Winterkorn's experiments on Putman soil, in which particular attention was given to obtain thorough leaching and final cleaning of the transformed soil. A. Marsland, England

1222. **Hashimoto, M., Some physical properties of the singing sands,** *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., 261–266, May 1952.

Singing sands are shown to have a very uniform grain size and to be fairly rounded with smooth clean surfaces. These properties cause rapid collapse of structure on shearing and consequently compression and rapid flow of the entrapped air, resulting in the production of audible sounds. A. Marsland, England

1223. **Matsui, T., On the flow of dry sand,** *Proc. 1st Japan nat. Congr. appl. Mech.*, 1951; Nat. Committee for Theor. appl. Mech., 365–370, May 1952.

The flow of dry sand is described mathematically by assuming that it behaves as a turbulent fluid. The justification for this assumption is obscure. More detailed experimental evidence is required before the validity of the theory can be assessed.

A. Marsland, England

Micromeritics

1224. **Ryley, D. J., Behaviour of water globules in steam,** *Engineer, Lond.* **198,** 5138, 74–78, July 1954.

This is a valuable contribution to the literature of accelerated motion of small particles. While the author sets out to treat the motion of water globules in steam, the special effects arising from the identity of substance in particle and vapor phase (e.g., condensation/evaporation effects, etc.) are disregarded and the treatment really is that appropriate to motion of a fluid particle in an alien gas. No new mathematical methods are devised, but useful results are obtained for the time and distance required by a water particle to reach 90% of its terminal velocity when falling in a horizontal stream of steam.

A particularly interesting section deals with the fracture of particles when either their size or their velocity relative to the gas exceeds a critical value. The basic formula for the incidence of fracture which is used in this study is

$$C_d\rho_s(V_s - V_w)^2 = 8\sigma/d_c$$

C_d is the drag coefficient, ρ_s the gas density, $(V_s - V_w)$ the relative speed between gas and particle, σ the surface tension of particle, d_c the critical particle diameter.

Interesting plots of $(V_s - V_w)$ vs. d_c for various values of the gas pressure are presented, but unfortunately no detailed discussion or derivation of this equation is given. Striking in these results is the exclusive dependence of d_c on the ambient pressure when the particles are very small, while in the aerodynamic region the critical particle size is a sensitive function of the relative velocity.

W. Hitschfeld, Canada

1225. **Wise, M. E., Converting a number distribution of particle size into one for volume or surface area,** *Philips Res. Rep.* **9,** 3, 231–237, June 1954.

A number distribution of equivalent radii of particles in a powder can be accurately converted into a distribution by volume or surface area, even if the data are highly and/or nonuniformly grouped. A formula is derived to do this and is applied to a microscopic analysis into a frequency distribution of radii between 1, $(2)^{1/3}$, 2, $2(2)^{1/3}$, 4,. . .units.

From author's summary

Geophysics, Meteorology, Oceanography

(See also Revs. 979, 1054, 1076, 1219)

1226. **Taylor, G. F., Elementary meteorology,** New York, Prentice-Hall, Inc., 1954, viii + 364 pp. $7.95.

"Because of the gradual shift of emphasis from the purely descriptive to the more interpretative approach to the science, it is felt that a new introductory text is justified. This book represents a sincere effort to write an elementary meteorology text that would maintain a professional flavor and approach throughout." (From Introduction.)

The book really starts at the beginning—the origin of the universe. Then comes a detailed chapter on meteorological elements and instruments, followed by the basic thermodynamic and dynamic processes and the physics of cloud and rain formation. These processes are next applied to the treatment of weather disturbances, including violent local storms and tropical weather. A summary of techniques of weather analysis and forecasting and a rather brief climatic chapter complete the text, to which 30 pages containing codes, conversion tables, and constants have been appended.

The general outline appears to be a logical and teachable one. Author certainly maintains the interpretative approach, and he is well up on the latest literature; e.g., theory of rain formation, extended weather forecasting, and synoptic climatology. However, while the inclusion of recent research is highly laudable, conclusions drawn from such research are often tentative and subject to debate. The tentative nature of the opinions presented by author might have been emphasized in several subjects such as jet streams and tropical weather.

The subject matter as a whole is confined to what might be called the meteorological core. Related subjects covered in some other introductory texts are largely omitted. For instance, there is no detailed treatment of pollution of the atmosphere. This, taken together with the professional slant maintained throughout the book, makes it clear that the book is intended mainly for students who expect to work in meteorology or who will require knowledge of what meteorologists do. Thus, the text should prove valuable for instruction of meteorological observers, airplane pilots, and students beginning professional training.

The book is very readable and author has brought in many examples from modern life. He has also gone to extreme pains to secure first-class diagrams and photographs. All illustrative material, including the reproduction, is superior.

H. Riehl, USA

1227. **Shiotani, M., Some notes on the structure of wind in the lowest layer of the atmosphere,** *J. meteor. Soc. of Japan* (2) **31,** 10, 327–335, Oct. 1953.

Author deduces certain characteristics of structure of a turbulent wind field from measurements of the frequency spectrum of turbulent energy. He postulates that Kolomogoroff's similarity hypothesis of local isotropy is applicable to the atmosphere. Measurements were made with hot-wire anemometer of horizontal and vertical components of wind over level snow surface. Photographic records are analyzed to yield autocorrelation coefficients for u and w of the approximate form $R_t = 1 - (t/T_0)^{2/3}$ for t less than 5 seconds. T_0 is the passing duration of the largest turbulent element, observed to increase with height. Author concludes that a range of turbulence scales exists in atmosphere near the ground in which the similarity hypothesis of local isotropy holds.

K. H. Jehn, USA

1228. **Giraud, P., and Kivéliovitch, M., Some remarks on the invariants of meteorology** (in French), *J. sci. Météor.* **4, 5,** 15, 19; 81–86, 127–128, July–Sept. 1952, July–Sept. 1953.

First paper contains a discussion of the Rossby-Ertel theorem [*Geofis. pura appl.* **XIV,** fasc. 3 and 4, 189–93] in Eulerian coordinates. Authors' contention is that Rossby-Ertel invariant is *not* conserved, but this conclusion is result of algebraic error in last line of p. 83 (as pointed out in the second paper). If error is corrected, the Rossby-Ertel theorem is recovered.

M. Wurtele, USA

1229. **Falckenberg, V. G., Radiation of the free atmosphere** (in German), *Z. Meteor.* **7,** 6, 162–167, June 1953.

Author has done considerable work on atmospheric radiation.

One of the important findings is the pressure dependence of the absorption coefficient of water vapor, which varies as the fourth root of p. This dependence was discussed by Schnaidt in 1939 and became one important reduction factor for all radiation computations for the atmosphere. However, this result holds only when the absorption is small and does not necessarily apply to the total absorption and radiation of the atmosphere. Recent measurements by the author show that the ratio between the atmospheric radiation and black-body radiation increases with height, which is not expected from any theoretical considerations. This demonstrates the necessity of more accurate measurements of the atmospheric radiation at different levels. Two accurate actinometers are developed, one suitable for use in airplane ascent, one for radiosonde ascent. H. L. Kuo, USA

1230. **Miyazaki, M., Tidal variations of oceanographical elements,** *Oceanogr. Mag.* **4,** 4, 149–158, Mar. 1953.

Theory is presented to account for amplitude and phase of oscillations of temperature and salinity at tidal periodicity which have been observed in coastal water at junction of two distinct water masses. On basis of one-dimensional, time-dependent model of diffusion with constant mixing coefficient, author shows that phase lag and amplitude of oscillation of oceanographic elements are greatest at center of boundary region. Amplitude decreases with width of this region and increases with amplitude of tidal currents. Phase lag approaches $3\pi/2$ for very wide boundary region. Comparison of theory with serial observations for Misaki Strait and for Irish Sea indicates fair agreement.

R. O. Reid, USA

1231. **Nishimura, G., Suzuki, M., and Furukawa, E., Theory of Eden's twin strips and application of it to magnifying mechanism of seismometer,** *Bull. Earthq. Res. Inst. Tokyo Univ.* **32,** part 1, 87–111, Mar. 1954.

Previous work on device known as "Eden's twin strips" is extended to discussion on its application to seismographs, in particular to accelerometers and displacement meters. Theory is given and checked against experiment using vibration table. Finally, record of an earthquake on an ordinary seismograph is compared with record of the same earthquake on a seismograph with twin strips. K. E. Bullen, Australia

Lubrication; Bearings; Wear

1232. **Osterle, F., Charnes, A., and Saibel, E., On the solution of Reynolds' equation for slider bearing lubrication. IX—The stepped slider with adiabatic lubricant flow,** First Ann. Conf. ASME-ASLE, Baltimore, Md., Oct. 1954. Pap. 54—LUB-11, 9 pp.

Paper deals with an analysis of the stepped slider without side leakage under the condition of adiabatic lubricant flow. The load-supporting capacity is computed by introducing the viscosity as a function of temperature and pressure, and taking approximate account of the variation of density. A numerical example illustrates the investigation and compares the results with those of the flat inclined-plane slider, which were published in a previous paper of the same series (IV) [AMR **7,** Rev. 3079].

G. Vogelpohl, Germany

1233. **Jacobson, M. J., Charnes, A., and Saibel, E., Studies in lubrication. X—The complete journal bearing with circumferential oil inlet,** First Ann. Conf. ASME-ASLE, Baltimore, Md., Oct. 1954. Pap. 54—LUB-10, 17 pp.

The end lubricated journal bearing is analyzed, using an approximate exponential function for film thickness in order to simplify calculations. Expressions for load capacity, coefficient of friction, axial thrust, and rate of flow are obtained from the end lubricated case and extended to a bearing with circumferential oil inlet. No negative pressure region is found by this solution.

M. C. Shaw, USA

1234. **Sassenfield, H., and Walther, A., Journal bearing calculations** (in German), *VDI-Forschungsheft* (*B*) **20,** 441, 28 pp., 1954.

Paper presents the unifying résumé of twelve papers on the mathematical analysis of hydrodynamical lubrication obtained so far in the Institute for Engineering Mathematics in Darmstadt, and gives pressure and bearing capacity of the full journal bearing (360° bearing) with inclined shaft, and of the 180° bearing with parallel shaft, both of finite length.

Starting with the Reynolds equation, a partial differential equation regarding pressure and film thickness is introduced with pertinent boundary conditions for 360° and 180° bearings, respectively, in nondimensional form. The equation is transformed into an equation with finite differences, and the resulting systems of linear equation are solved by means of the modernized Gauss algorithm. Remarks on carrying out the computation are given and the accuracy of the present method is also discussed.

The results of numerical calculations are summarized for both bearings in the form of twelve numerical tables and of 61 diagrams. These involve the angular positions at which the most thin film or the maximum pressure occurs, and various parameters representing the bearing performances in relation to the dimensions of shaft and bearing. H. Mii, Japan

1235. **Junge, C. H., Wear in bearings,** *ASTM Bull.* no. 198, 64–69, May 1954.

Paper describes four types of damage encountered in sleeve bearings, including fatigue, scoring or seizure, corrosion, and erosion. In each instance the nature of the damage is discussed and illustrated, and possible mechanisms whereby the damage is caused are postulated. A comparison chart for the load-carrying capacities of ten modern bearing materials is presented.

C. D. Strang, Jr., USA

1236. **Mougey, H. C., Engine wear as affected by lubricant composition,** *ASTM Bull.* no. 198, 57–63, May 1954.

A review of wear problems affecting the modern automobile engine with emphasis on cylinder wear resulting from the combined action of mechanical rubbing and corrosion by water and combustion products. Extended low-temperature operation and intermittent stop-and-start service aggravate this form of wear, which may be combatted with oil additives for rust resistance. It is pointed out that the newer engines use higher surface loadings and straight mineral oils are no longer satisfactory for all-around use. Additives which provide an extreme pressure action would appear to be helpful. C. D. Strang, Jr., USA

1237. **Davies, R., Hydrodynamic lubrication of a cam and a cam follower,** First Ann. Conf. ASME-ASLE, Baltimore, Md., Oct. 1954. Pap. 54—LUB-13, 7 pp.

Paper reviews theoretical concepts of the lubrication between a cam and its follower. Differential equations for thin oil film lubrication are applied and it is assumed that cam profile approximates a parabola. Integration gives the pressure as a function of the variable along the periphery of the cam. Two unknown constants of integration and the minimum film thickness are evaluated by the conditions that pressure should have a minimum shortly after the oil passes the region of minimum film

thickness, and should be far away in the negative X-direction. Considering that the force between cam and follower could be obtained by the integration of pressure along the length of contact, and that maximum pressure occurs where pressure gradient is zero, the values of minimum thickness and maximum pressure are expressed as a function of oil viscosity, cam velocity, radius of curvature, force, and length of contact. An example indicates that minimum thickness could be extremely small and maximum pressure could approach the yield point of the metal. Reviewer believes this is an outstanding theoretical contribution, but it would be desirable to be followed by experimental observations. N. Theophanopulos, Greece

1238. Peterson, M. B., and Johnson, R. L., Friction of possible solid lubricants with various crystal structures, *NACA TN* 3334, 32 pp., Dec. 1954.

A number of possible solid lubricants with various crystal structures were tested in a low-speed, high-load, friction apparatus under conditions of continuous sliding. Some solids with the $CdCl_2$, CdI_2, MoS_2, and other layer-lattice types provided effective lubrication. Those materials include CdI_2, $CdCl_2$, PbI_2, $CoCl_2$, $AgSO_4$, $CuBr_2$, and WS_2. They were not as effective as MoS_2 but were at least as effective as zinc stearate and graphite in these tests. Not all solids with these structures were good lubricants; the criterion for good lubrication over extended periods seemed to be the formation of a film on both mating specimens. Some low-shear-strength materials that did not have a layer-lattice structure afforded surface protection.

From authors' summary

Marine Engineering Problems

1239. Schuster, S., Investigations of flow and drag conditions of ships in motion in water of limited depth and width (in German), *Jahrb. Schiffbautech. Gesellsch.* **46,** 244–288, 1952.

An extensive discussion of existing literature and theories is given. The problems of limited depth, and ship motion in channels of limited width, are discussed in the light of various theories and experiments. In particular, the results of model experiments are discussed. The theories of wave form and wave propagation are extended and hydraulic considerations are discussed. In concluding the paper, author notes that the problems of limited depth and limited width of water are different and cannot be treated by a uniform theory. Author recommends the use of the nomogram developed in the paper for the treatment of actual problems of ship motion in limited waters. Discussions of the paper by F. Horn, G. Weinblum, W. Graff, R. O. Schlichting, H. Dickmann, and Klindwort are given, together with the reply of author. T. P. Torda, USA

1240. Klindwort, E., Experiences in profiling and propulsion of seagoing ships at intermediate Froude numbers (in German), *Jahrb. Schiffbautech. Gesellsch.* **47,** 73–106, 1953.

Author reports on experience gained before World War II, predominantly in model experiments. These experiments were carried out by the Hamburg Shipdesign Experiment Station in co-operation with the firm of Blohm and Voss. The first part of the paper deals with the bow shape as developed by Blohm and Voss. It gives the history of its development, applications, and the experience gained with this shape. The second part gives a short discussion of experiments with the Kort nozzle. The third part deals with the question of using two or three propellers for propulsion. In the fourth part, experiments are discussed in which the Dutch and German designs are compared. The fifth part deals with bulbous bows.

Author points out in the concluding remarks that no final answers were obtained for the problems investigated and also that basic research should be carried out in clarifying the phenomena involved. Comments on the paper by H. Amtsberg, G. Weinblum, and R. O. Schlichting are given also, together with an answer by the author. T. P. Torda, USA

1241. Weinblum, G. P., Recent progress in theoretical studies on the behavior of ships in a seaway, *European Shipbldg.* **4,** 3, 74–79, 1954.

Brief synopsis of recent theoretical works in this field and their contribution to the practical study of seagoing qualities of ships. References are made to reports which yield quite new aspects of the following subjects: oscillations of a ship in a regular seaway, motions in initially calm water, exciting forces, ship mechanics in seaway (directional stability and transverse stability), statistical approach of the study of motions in a confused sea.

R. G. A. Spronck, Belgium

1242. Stenvaag, O., and Garberg, A., Transverse stability of whalers when in longitudinal motion (in Norwegian), *Tekn. Skr.* nr. 10 N, 14 pp., 1954.

Two models of whale catchers were tested for stability when under speed in the ship model basin at Trondheim. Referred to ship length of 100 ft, both had metacentric height of 23.6 in. at zero speed. They were inclined by weight moved thwartship. Increment of lever to keep inclination constant during run was measured. Speeds varied from 7.5 to 12 knots (for 100-ft ship). Results show that, for moderate heels (below 15°), righting arms were independent of speed below 9.5 knots, while for larger heels there was a slight reduction in righting arms with increasing speed, a minimum value of righting arms occurring at 9.5 knots. Above 9.5 knots, righting arms increased rapidly with increasing speed for all angles of heel. Bilge keels had only a slight effect on righting arms under speed. Tests were made in still water.

G. Vedeler, Norway

1243. Johnson, A. J., and Meek, M., Stresses in a tanker during launching, *Engineering* **177,** 4595, p. 238, Feb. 1954.

1244. Birmington, J. T., Strain and deflections of portable Evans dunnage members installed on USS Diamond Head (AE 19), *David W. Taylor Mod. Basin Rep.* 884, 5 pp., 6 figs., Dec. 1953.

1245. Gilbert, P. T., The resistance to failure of condenser and heat exchanger tubes in marine service, *Trans. Inst. mar. Engrs.* **66,** 1, 1–6, Jan. 1954.